Final Report

2007 FUTURE YEAR OZONE MODELING FOR THE DALLAS/FORT WORTH AREA

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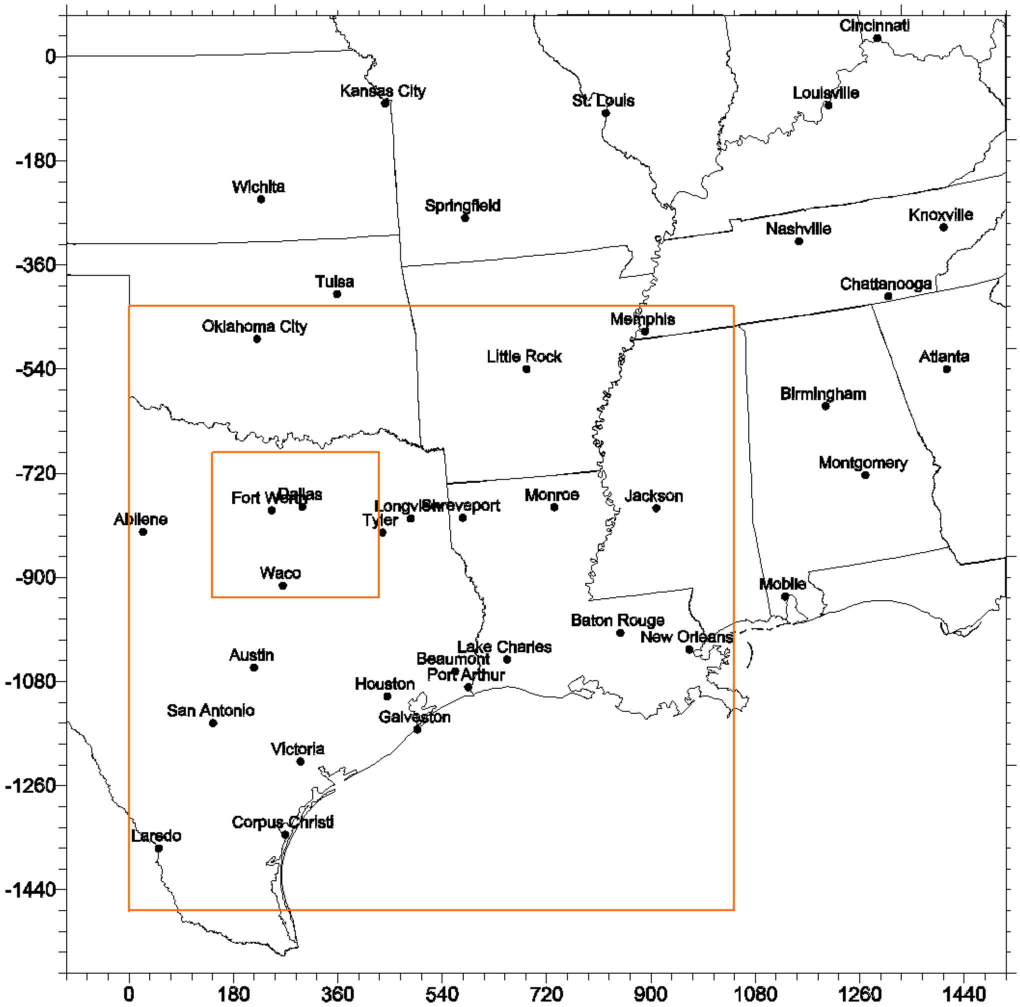
1.0 INTRODUCTION

This report describes the results of initial 2007 future year ozone modeling of the Dallas/Fort Worth (DFW) area using and August 1999 episode. The development of the August 13-22, 1999 episode by ENVIRON for the TCEQ was described previously by Mansell et al., (2003). The future year ozone results for 2007 described here will be used by the TCEQ in planning activities for the 1-hour ozone standard.

The TCEQ will be considering the 8-hour ozone standard using ozone modeling results for a 2010 future year when they become available. This report includes an 8-hour ozone analysis for 2007 as an indication of progress toward meeting the 8-hour ozone standard by 2007. The analysis of 8-hour ozone uses the "design value scaling" (DV scaling) method described by EPA in the draft 8-hour ozone modeling guidance (EPA, 1999). The DV scaling method looks at relative changes in modeled ozone from the base year to the future year and therefore is sensitive to any inconsistencies between the base and future year modeling, such as changes in emission inventory assumptions. The 8-hour ozone analysis presented here for 2007 is preliminary because: (1) The 8-hour analysis relies upon 1999 ozone modeling results that use an inventory that needs to be updated to match the 2007 inventory, and; (2) The final 8-hour ozone modeling will be for 2010 not 2007.

The 2007 future year ozone modeling described here used the latest version 4.03 of the CAMx model. The previous 1999 base case modeling (Mansell et al., 2003) was performed using CAMx version 4.02. The 1999 base case was re-run using CAMx version 4.03 to update the model performance evaluation and provide a consistent set of modeling results the base and future years. As just discussed, consistency between 1999 and 2007 modeling methods is particularly important for 8-hour ozone when the DV scaling method is used.

The modeling domain for this study, shown in Figure 1-1, provides a 4-km high-resolution grid in the DFW area nested within 12-km and 36-km grids covering much of the South, Southeast and Central US. This modeling domain was designed to provide high-resolution for all sources in the DFW area and also include all regional sources within a 2-3 day transport time of DFW.



CAMx GRID DIMENSIONS
LCP Grid with reference origin at (40 N, 100 W)

36 km Grid: 45 x 46 cells from (-108, -1584) to (1512, 72)
12 km Grid: 87 x 87 cells from (0, -1476) to (1044, -432)
4 km Grid: 72 x 63 cells from (144, -936) to (432, -684)

(nested grid dimensions do not include buffer cells)

Figure 1-1. CAMx modeling domain for the August 1999 episode showing the 36-km regional grid and the nested 12-km and 4-km fine grids.

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2.0 EMISSIONS PROCESSING

The August 13-22, 1999 episode, a Friday through Sunday, was being modeled in CAMx using a Lambert Conformal Projection (LCP) nested grid configuration with grid resolutions of 36, 12 and 4-km (Figure 1-1). In CAMx, emissions are separated between surface (surface and low level point) emissions and elevated point source emissions. For the surface emissions, a separate emission inventory is required for each grid nest, i.e., three inventories. For elevated point sources, a single emission inventory is prepared covering all grid nests.

Two emissions modeling domains are used to generate the required CAMx ready inventories:

1. **Dallas/Fort Worth Non-Attainment Area 4-km Grid**. The DFW emissions grid has 72 x 63 cells at 4-km resolution and covers the same area as the CAMx 4-km nested grid shown in Figure 1-1.

2. **Regional Emissions Grid**. Emissions for the CAMx 36-km and 12-km grids are prepared together in a single emissions processing step for efficiency. The regional emissions grid has 135 x 138 cells at 12-km resolution and covers the full area shown in Figure 1-1. This emissions grid is used for the 12-km CAMx grid by "windowing out" emissions for the appropriate region. In addition the regional emissions grid is aggregated from nine 12-km cells to one 36-km cell over the entire area to generate the CAMx 36-km grid.

DATA SOURCES FOR 1999

The development of emission inventories for the 1999 base year is documented in Mansell et al., 2003. Table 2-1 provides a summary of data sources used in the development of the 1999 inventory. Emission summaries for 1999 by source category and county were presented in Mansell et al., 2003.

Table 2-1. Summary of emissions data sources for 1999.

Category	Region	Data Source
Mobile	DFW	NCTCOG link-based, MOBILE6
	Texas major urban	TTI link-based, MOBILE6 via TCEQ
	Other Texas	TTI county level, MOBILE6 via TCEQ
	Outside Texas	EPA NEI99 Version 2, MOBILE6
Offroad	Texas	NONROAD 2002 model
	DFW	NCTCOG local data and NONROAD 2002 model
	Outside Texas	EPA NEI99 Version 2
Area	Texas	TCEQ
	Outside Texas	EPA NEI99 Version 2
Point	TX and LA EGU	EPA acid rain hourly data processed by TCEQ
	Texas other	1999 PSDB
	Louisiana other	LA DEQ provided to TCEQ
	OK EGU	EPA acid rain hourly data processed by ENVIRON
	OK other	EPA NEI99 Version 2 with ODEQ corrections
	Other	EPA NEI99 Version 2
Offshore	Texas	TCEQ offshore and shipping emissions
Biogenic	DFW	GloBEIS3.1 with TCEQ LULC data
	Outside DFW	GloBEIS2.2 with TCEQ and BELD3 LULC data

DATA SOURCES FOR 2007

The future year 2007 emission inventory was developed jointly by ENVIRON and TCEQ. The TCEQ developed gridded, model-ready emissions files for area and off-road mobile source for the entire state of Texas for both the 12-km regional and 4-km DFW emissions grids. On-road mobile source emissions for all areas were based on EPA's MOBILE6 model. Off-road mobile source emissions were based on the 2002 version of EPA's NONROAD model for most source categories. Point source emissions were based on data from TCEQ's point source database (PSDB) and EPA's National Emissions Inventory. Area source emissions for Texas were based on TCEQ data and other states were based on EPA's data developed for a rulemaking on heavy-duty diesel (HDD) engines. Biogenic emissions were unchanged from the 1999 base case inventory as described by Mansell, et al. (2003).

The data sources for the 2007 emissions inventories are described in more detail below followed by summary tables of gridded emissions by county and source category. Spatial plots of the 2007 NOx, VOC and CO emissions by source category for the August 17 episode day are presented for the 12-km and 4-km grids.

On-Road Mobile Sources

All on-road mobile source emissions were based on EPA's MOBILE6 model. Control measures for on-road mobile sources were modeled using MOBILE6.

DFW: On-road mobile source emissions were developed by NCTCOG for TCEQ using MOBILE6.2. The modeling files were downloaded from TCEQ's FTP server: ftp://ftp.tnrcc.state.tx.us/pub/OEPAA/TAD/Modeling/file_transfer/TXareaNR/files
The following files were provided:
- dfw_04km_07.18Fed2004.tar
- reg_12km.fy07e.regular_tx_os_mex.tar

The DFW on-road mobile emissions are based on a 5-day work week.

NE Texas: Link-based emissions from MOBILE6.2 for 4 day of week scenarios (Monday – Thursday, Friday, Saturday, Sunday) and 2007 vehicle miles traveled (VMT) and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.

Rest of Texas: County-level emissions from MOBILE6 for 4 day of week scenarios and 2007 VMT and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.

Other States: MOBILE6.2 county level emissions for typical summer day conditions (as used in the NEI999v2) with EPA data for 2007 VMT and fleet turnover.

Off-Road Mobile Sources

Off-road mobile source emissions for all categories except aircraft, commercial marine and locomotives were from EPA's 2002 version of the NONROAD model (NONROADv2002). The

TCEQ developed the NONROAD model input data for Texas and EPA's data were used elsewhere. Emissions for aircraft, commercial marine and locomotives are not included in NONROAD and so were estimated by TCEQ and EPA for 1999 and projected to other years using EPA data including the Economic Growth Analysis System (EGAS).

Texas: TCEQ provided gridded model-ready off-road mobile source emissions data. The modeling files were downloaded from TCEQ's anonymous FTP server: ftp://ftp.tnrcc.state.tx.us/pub/OEPAA/TAD/Modeling/file_transfer/TXareaNR/files
The following files were provided:
- dfw_04km_07.18Fed2004.tar
- reg_12km.fy07e.regular_tx_os_mex.tar

Other States: NONROADv2002 with default input data for 2007. Aircraft, commercial marine and railroad emissions for 2007 developed by EPA for a rulemaking on "heavy duty diesel" emissions.

Area Sources

Emissions for stationary sources that are not individually inventoried (area sources) were based on data developed for 1999 by TCEQ and EPA. Emissions for years later than 1999 were projected using EGAS and other data.

Texas: TCEQ provided gridded model-ready off-road mobile source emissions data. The modeling files were downloaded from TCEQ's FTP server: ftp://ftp.tnrcc.state.tx.us/pub/OEPAA/TAD/Modeling/file_transfer/TXareaNR/files
The following files were provided:
- dfw_04km_07.18Fed2004.tar
- reg_12km.fy07e.regular_tx_os_mex.tar

Other States: EPA 2007 emission inventory developed for a rulemaking on "heavy duty diesel" emissions.

Point Sources

Emissions for stationary sources that are inventoried individually (point sources) were based on data from TCEQ, EPA and the Louisiana DEQ (LDEQ). The TCEQ provided model-ready point source emissions data for the entire modeling domain. Gridded low-level point source emission files were provided for both the 12-km regional and 4-km DFW modeling domains. The data were downloaded from TCEQ's FTP server: ftp://ftp.tnrcc.state.tx.us/pub/OEPAA/TAD/Modeling/DFWAQSE/Modeling/EI/Points/2007.

The following files were provided:
- dfwmcr_2007_points.tar.gz

Biogenic Emissions

Biogenic emissions were prepared using both versions 2.2 and 3.1 of the GloBEIS model (Yarwood et al., 1999 a,b). The GloBEIS model was developed by the National Center for Atmospheric Research and ENVIRON under sponsorship from the TCEQ.

GloBEIS Version 2.2

GloBEIS version 2.2 was based on the EPA BEIS2 model algorithms with the following improvements:

- Updated emission factor algorithm (called the BEIS99 algorithm).
- Compatible with the EPA's Biogenic Emission Landcover Database – Version 3 (BELD-3).
- Compatible with the TCEQ's Texas specific landcover database which includes local surveys of DFW vegetation (Yarwood et al., 1999b).
- Ability to directly input solar radiation data for photosynthetically active radiation (PAR).

GloBEIS 2.2 requires input data for landuse/landcover (LULC), temperature and solar radiation. The TCEQ provided these data for the August 1999 episode period (Yarwood et al., 2001). Briefly, these data were:

- TCEQ LULC data for Texas and Mexico.
- EPA BELD-3 LULC data for all other U.S. States.
- Hourly temperature data from interpolated NWS observations.
- Hourly solar radiation (PAR) based on GOES satellite data as analyzed by the University of Maryland.

GloBEIS Version 3.1

GloBEIS, version 3.1, was released in 2002 (Guenther et al., 2002) and has the following changes from version 2.2:

- Options to model the impacts of drought and prolonged periods of high temperature.
- Optional leaf energy balance model.
- Optional direct input of leaf area index (e.g., from satellite data).
- Option to model effects of leaf age on emissions (seasonal effects).
- Chemical speciation for the SAPRC99 and CB4 mechanisms.
- Updated speciation of other VOC emissions.
- GloBEIS3 emission factor model (previously called BEIS99).

GloBEIS3.1 and GloBEIS2.2 codes calculate the same emissions when using the same input data. Using the options to model drought impacts and prolonged periods of high temperature requires input data for humidity and wind speed in addition to temperature. It is important for these humidity and temperature inputs to be consistent (e.g., from a meteorological model such as MM5).

Biogenic Inventory Preparation

GloBEIS was used to calculate day specific, gridded, speciated, hourly emissions of biogenic VOCs and NOx for each modeling grid (36-km, 12-km, 4-km). The model versions and input data were as follows.

DFW 4-km grid area: Biogenic emissions were calculated using GloBEIS3.1 with TCEQ LULC data, MM5 temperature data and GOES satellite PAR data.

Texas outside of the DFW 4-km grid area: Biogenic emissions were calculated using GloBEIS2.2 with TCEQ LULC data, interpolated observed temperature data and GOES satellite PAR data.

States outside of Texas: Biogenic emissions were calculated using GloBEIS2.2 with BELD-3 LULC data, interpolated observed temperature data and GOES satellite PAR data.

Mexico: Biogenic emissions were calculated using GloBEIS2.2 with TCEQ LULC data, interpolated observed temperature data and GOES satellite PAR data.

EMISSION SUMMARIES FOR 2007

The emission inventories for 2007 are summarized in Tables 2-2 through 2-5. These tables are:

- Table 2-2 shows the 2007 NOx emissions for DFW area counties by source category.
- Table 2-3 shows the 2007 VOC emissions for DFW area counties by source category.
- Table 2-4 shows the 2007 CO emissions for DFW area counties and day-of-week.
- Table 2-5 shows the 2007 NOx and VOC emissions for the entire modeling domain broken out by several geographic areas.

Tables 2-2 through 2-4 provide detailed information for the DFW area by day of week and source category. The days of week shown in Tables 2-2 through 2-4 are August 18th (weekday), August (21 (Saturday) and August 22 (Sunday). Table 2-5 shows the emission inventories for the entire modeling domain in a concise format for just the August 17th day (Tuesday). The geographic areas used in Table 2-5 are the same as used in previous ozone source apportionment modeling (Mansell et al., 2003) as defined in Figure 2-1. The source categories in Tables 2-5 through 2-7 are biogenic, on-road mobile, major point and other anthropogenic sources. The other anthropogenic category combines area and off-road mobile sources. Table 2-8 provides the definition of the source regions corresponding to the numbered regions in Figure 2-1.

Table 2-5 is prepared directly from model ready emissions files and this introduces some uncertainty into the emissions totals because: (1) County boundaries are approximated to the nearest grid-cell boundary, and; (2) The emissions processing provides CAMx with moles of emissions rather than tons of emissions. Therefore, in the case of minor differences between Tables 2-2 through 2-4 and Table 2-5, the former should be considered more accurate. Also, the weekday in Tables 2-2 through 2-4 is August 18th whereas Table 2-5 is for August 17th.

Table 2-6 shows the same information as Table 2-5 but for the 1999 base year rather than 2007 future year emission inventory. Comparing Tables 2-5 and 2-6 shows the trends in emissions from the base to future year resulting from the combined effects of activity growth and emission control strategies. Table 2-7 shows the ratio of the 2007 to 1999 emissions shown in Tables 2-6 and 2-5. In a few cases the ratios are large numbers because the 1999 emissions were very low, so care is needed in interpreting the ratios shown in Table 2-7. The following points are noted from the emissions trend analysis shown in Table 2-7:

- There are significant reductions in on-road mobile source NOx and VOC emissions in all regions (except for NNA) from 1999 to 2007 resulting from cleaner vehicles and fuels.
- The on-road mobile source NOx emission reductions are influenced by new standards for heavy-duty diesel vehicles and therefore the overall on-road mobile source NOx reduction tends to be larger in areas with a high contribution from truck traffic.
- The anomalous increase in on-road mobile source NOx and VOC emissions for the region NNA (region 23 in Figure 2-1) is likely due to different assumptions in the base and 2007 emissions and should be investigated.
- There are significant reductions in elevated point source NOx emissions in most regions from 1999 to 2007.
- The 2007 Point source NOx in the 4 core counties is substantially reduced, but increases in the surrounding 12 counties.
- Point source NOx emissions are substantially in 2007 for the "Other" region (region 25 in Figure 2-1) due to EPA's NOx SIP call.
- Point source NOx emissions are substantially lower in 2007 for Louisiana. This difference was found to be due to double counting the LA non-EGU emissions in the 1999 inventory. This should be corrected when the 1999 inventory is updated.
- Reductions in "other anthropogenic" NOx emissions tend to be less than for on-road mobile or point sources. Other anthropogenic combines off-road mobile, area and low-level point sources.

The spatial distribution of the emissions is shown by source category in Figures 2-2 through 2-7. The 4-km grid model ready emissions for Tuesday August 17th are shown in Figures 2-2 through 2-4 for NOx, VOC and CO, respectively. Figures 2-5 through 2-7 show the corresponding information for the 12-km CAMx grid.

The dates shown in the PAVE legends in Figures 2-2 through 2-7 are sometimes different from August 17th, 1999. This does not indicate any problems with the emission inventory: rather, future year area, off-road and low-level point emissions were prepared for representative weekdays from a Houston modeling episode (Tuesday August 29, 2000 or Thursday August 31, 2000) and used for DFW future case weekdays.

Table 2-2. 2007 NOx emissions by source category for the DFW area counties.

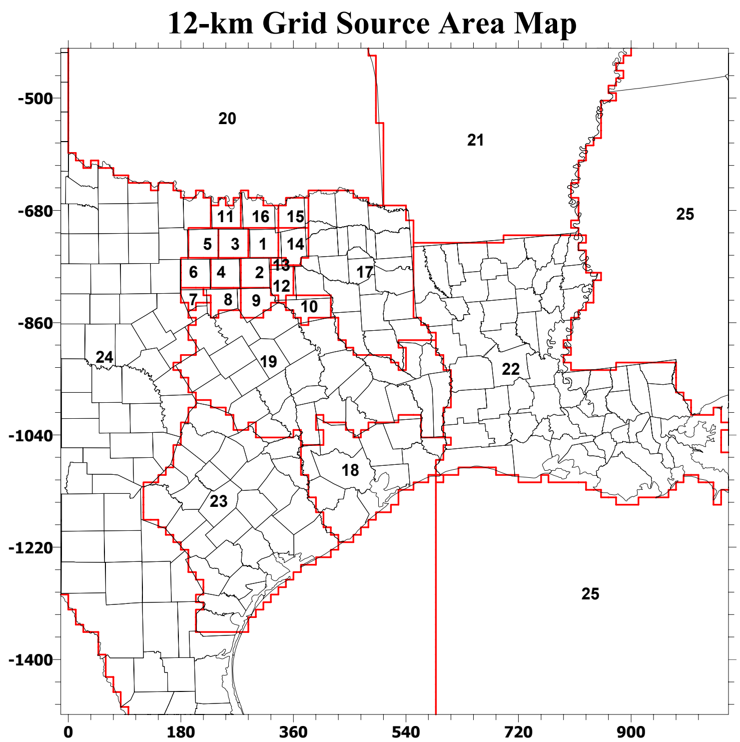
2007 NOx emissions (tons/days)															
	Area			On-road Mobile			Off-road Mobile			Points			Total Anthropogenic		
County	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**
Colin	2.3	1.7	1.2	18.2	12.9	9.1	20.3	13.4	10.2	3.8	2.9	3.4	**44.5**	**30.8**	**24.1**
Cooke	0.2	0.2	0.2	2.9	2.1	1.6	2.9	2.8	2.7	0.0	0.0	0.0	**6.0**	**5.1**	**4.5**
Dallas	17.8	13.0	8.2	86.8	60.2	43.9	62.9	46.6	37.1	17.8	17.7	17.3	**185.4**	**136.3**	**106.5**
Denton	2.5	2.2	1.8	18.3	12.5	9.0	9.5	7.0	5.6	2.8	2.7	2.6	**33.1**	**24.3**	**19.1**
Ellis	0.3	0.3	0.2	10.0	7.7	7.0	11.2	8.0	6.5	72.4	72.4	72.4	**93.9**	**88.2**	**86.1**
Fannin	0.2	0.2	0.2	1.2	0.9	0.8	0.9	0.8	0.7	15.8	7.9	8.1	**18.2**	**9.8**	**9.8**
Grayson	0.4	0.4	0.4	5.2	3.7	3.1	4.7	4.5	4.3	1.3	1.3	1.3	**11.6**	**9.9**	**9.0**
Henderson	1.1	1.1	1.0	2.6	2.6	2.4	3.6	3.7	3.6	6.5	7.1	7.1	**13.8**	**14.4**	**14.2**
Hood	1.1	1.1	1.0	1.2	1.2	1.2	0.7	0.5	0.4	20.8	19.3	21.2	**23.7**	**22.0**	**23.8**
Hunt	0.3	0.2	0.2	5.4	4.7	4.3	2.5	2.2	1.9	0.3	0.3	0.1	**8.5**	**7.4**	**6.7**
Johnson	0.3	0.3	0.2	5.4	4.9	4.5	7.5	7.0	6.7	5.7	5.7	5.7	**19.0**	**17.7**	**17.2**
Kaufman	0.2	0.2	0.1	7.3	6.0	5.5	3.9	3.5	3.2	8.4	8.4	8.4	**19.8**	**18.0**	**17.3**
Parker	3.9	3.9	3.8	6.6	5.3	4.8	4.3	4.0	3.8	6.7	6.8	6.9	**21.5**	**19.9**	**19.2**
Rockwell	0.1	0.1	0.1	3.7	2.2	1.5	1.3	0.8	0.6	0.0	0.0	0.0	**5.2**	**3.1**	**2.2**
Tarrant	9.0	6.5	4.1	53.9	37.7	27.0	52.3	40.9	34.4	12.5	12.1	12.7	**127.7**	**97.3**	**78.4**
Wise	13.0	13.0	13.0	3.1	2.1	1.5	5.6	5.5	5.4	11.3	11.3	11.3	**33.1**	**31.9**	**31.2**
Total	**52.9**	**44.2**	**35.5**	**231.9**	**166.8**	**127.2**	**193.8**	**151.2**	**127.2**	**186.1**	**175.9**	**178.5**	**664.8**	**536.1**	**469.3**

Table 2-3. 2007 VOC emissions by source category for the DFW area counties.

2007 VOC emissions (tons/days)															
	Area			On-road Mobile			Off-road Mobile			Points			Total Anthropogenic		
County	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**
Colin	15.8	11.2	7.7	10.7	8.0	6.5	6.0	8.0	7.1	1.4	1.4	1.4	**33.9**	**28.7**	**22.7**
Cooke	7.8	6.5	5.5	1.6	1.4	1.2	1.0	2.6	2.5	0.1	0.1	0.1	**10.5**	**10.6**	**9.3**
Dallas	73.6	40.8	27.7	49.1	36.6	30.0	29.3	36.2	32.4	13.2	13.2	13.2	**165.1**	**127.2**	**103.2**
Denton	19.0	12.1	9.3	10.0	7.5	6.1	4.8	9.9	9.3	1.9	1.9	1.9	**35.7**	**31.5**	**26.6**
Ellis	10.3	6.9	4.0	2.8	3.1	3.2	2.2	3.3	3.0	8.6	8.6	8.6	**23.9**	**21.9**	**18.9**
Fannin	3.5	2.4	1.7	0.7	0.7	0.6	0.3	0.3	0.3	0.4	0.2	0.2	**4.8**	**3.6**	**2.7**
Grayson	7.0	4.8	3.0	2.7	2.5	2.4	1.5	2.6	2.5	0.1	0.1	0.1	**11.2**	**10.1**	**8.0**
Henderson	8.0	6.2	4.8	2.0	2.2	2.4	2.1	6.6	6.5	0.7	0.7	0.7	**12.7**	**15.8**	**14.3**
Hood	3.1	2.6	1.9	0.9	1.0	1.1	0.4	1.2	1.2	0.7	0.7	0.7	**5.1**	**5.5**	**4.9**
Hunt	9.6	4.8	2.2	2.6	3.0	3.1	2.0	5.0	4.9	0.1	0.1	0.1	**14.3**	**13.0**	**10.3**
Johnson	8.7	5.3	2.9	2.6	2.9	3.0	0.9	1.4	1.2	0.8	0.8	0.8	**13.0**	**10.3**	**7.9**
Kaufman	10.7	4.6	2.7	2.9	3.2	3.4	1.0	2.1	2.0	2.2	2.2	2.2	**16.7**	**12.1**	**10.2**
Parker	8.9	7.3	5.6	2.3	2.5	2.7	1.0	1.8	1.6	1.1	1.1	1.1	**13.3**	**12.7**	**11.0**
Rockwell	2.5	1.6	1.0	1.0	0.8	0.6	0.7	1.7	1.6	0.0	0.0	0.0	**4.2**	**4.1**	**3.2**
Tarrant	58.1	27.9	19.1	29.5	22.2	18.1	18.0	24.2	21.6	10.0	9.9	10.0	**115.5**	**84.4**	**68.7**
Wise	18.4	17.1	16.2	1.9	1.5	1.2	1.0	2.3	2.2	2.2	2.2	2.2	**23.5**	**23.1**	**21.8**
Total	**264.8**	**162.1**	**115.2**	**123.3**	**99.1**	**85.6**	**72.1**	**109.1**	**99.9**	**43.4**	**43.1**	**43.2**	**503.5**	**414.5**	**343.6**

Table 2-4. 2007 CO emissions by source category for the DFW area counties.

2007 CO emissions (tons/days)															
	Area			On-road Mobile			Off-road Mobile			Points			Total Anthropogenic		
County	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**	**Wkd**	**Sat**	**Sun**
Colin	7.7	6.0	4.4	149.8	120.1	101.3	100.5	123.0	103.1	2.9	2.9	2.9	**260.9**	**253.4**	**210.2**
Cooke	1.6	1.5	1.4	21.2	20.6	18.1	8.6	15.8	14.2	0.0	0.0	0.0	**31.4**	**38.0**	**33.7**
Dallas	32.1	18.2	4.6	679.7	543.4	454.8	562.6	669.2	584.9	15.8	15.8	16.2	**1290.2**	**1257.1**	**1057.6**
Denton	5.5	4.7	4.0	142.8	116.5	98.1	61.0	96.0	82.3	1.6	1.6	1.6	**210.9**	**220.2**	**185.1**
Ellis	3.5	2.5	1.5	40.0	46.7	50.9	24.4	34.3	29.2	66.1	66.1	66.1	**134.0**	**150.5**	**147.5**
Fannin	2.5	2.3	2.1	8.7	8.8	8.2	5.2	7.2	5.7	5.4	2.5	2.5	**21.9**	**20.7**	**18.5**
Grayson	2.9	2.7	2.5	33.3	33.3	31.1	13.2	20.5	17.5	0.2	0.2	0.2	**49.6**	**56.7**	**51.3**
Henderson	2.1	1.7	1.3	22.9	26.2	28.3	15.6	35.9	33.0	4.7	4.9	4.9	**45.4**	**69.1**	**67.2**
Hood	1.6	1.4	1.3	11.1	12.3	13.4	6.1	12.0	10.6	8.7	8.7	8.7	**27.5**	**34.7**	**34.1**
Hunt	2.1	1.7	1.3	32.7	38.2	41.4	16.3	29.9	26.5	0.1	0.1	0.1	**51.2**	**70.4**	**68.8**
Johnson	1.8	1.2	0.7	32.2	36.0	39.4	15.2	23.4	19.0	6.2	6.2	6.2	**55.4**	**67.6**	**65.1**
Kaufman	1.3	0.9	0.5	37.2	42.8	46.5	16.7	26.4	23.7	6.3	6.3	6.3	**61.4**	**77.0**	**76.4**
Parker	5.4	5.1	4.8	28.9	32.9	36.3	14.2	23.4	20.5	5.5	5.5	5.5	**54.0**	**67.5**	**67.0**
Rockwell	0.8	0.7	0.5	16.6	13.4	11.1	9.3	13.9	12.3	0.0	0.0	0.0	**26.6**	**28.1**	**23.9**
Tarrant	17.8	10.1	2.6	422.2	339.6	284.8	276.8	366.0	306.0	13.7	12.8	13.7	**730.4**	**732.3**	**606.5**
Wise	16.5	16.3	16.2	25.0	21.7	17.0	9.9	16.5	14.9	9.2	9.2	9.2	**60.7**	**63.7**	**57.3**
Total	**105.2**	**77.2**	**49.7**	**1704.3**	**1452.5**	**1280.5**	**1155.4**	**1513.5**	**1303.5**	**146.5**	**142.8**	**144.2**	**3111.4**	**3207.1**	**2770.0**



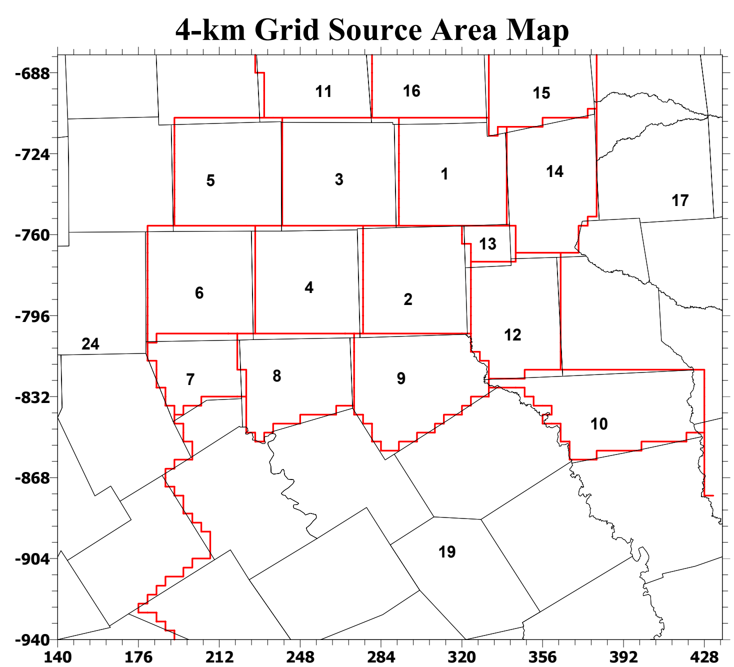


Figure 2-1. Emissions source areas used to prepare the emission summary tables by geographic area. The areas are described in Table 2-8.

ENVIRON

Table 2-5. Summary of 2007 model ready emissions for Tuesday August 17th by source region and category.

Source	Biogenic		On-road Mobile		Other Anthropogenic*		Major Point	
Region	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**
Colin Co.	11.2	29.0	16.4	8.7	21.0	22.4	3.0	0.2
Dallas Co.	4.2	56.2	89.2	44.3	81.9	112.8	15.2	4.2
Denton Co.	8.1	66.4	19.8	9.3	12.3	23.8	2.5	1.0
Tarrant Co.	2.9	65.5	60.0	28.8	67.3	87.9	9.5	2.1
Core	**26.4**	**217.2**	**185.4**	**91.0**	**182.5**	**246.9**	**30.2**	**7.5**
Wise Co.	2.3	149.5	3.1	1.7	20.3	19.9	9.0	0.8
Parker Co.	0.6	130.9	7.2	2.3	8.7	10.7	6.4	0.5
Hood Co.	0.2	34.5	1.2	0.8	1.9	3.8	20.8	0.6
Johnson Co.	4.8	108.3	6.3	2.7	9.1	11.0	4.2	0.2
Ellis Co.	14.3	89.7	10.0	2.6	18.9	16.2	64.8	4.3
Henderson Co.	0.7	275.5	3.3	2.1	5.9	11.9	5.6	0.2
Cooke Co.	3.7	88.5	3.1	1.6	3.0	10.4	0.0	0.0
Kaufman Co.	5.0	105.8	7.1	2.6	4.5	11.4	7.7	1.6
Rockwall Co.	1.6	3.6	3.3	0.9	1.3	3.0	0.0	0.0
Hunt Co.	6.8	77.2	5.7	2.4	2.9	11.6	0.2	0.0
Fannin Co.	7.1	120.9	1.1	0.6	1.5	4.4	0.0	0.0
Grayson Co.	9.1	144.8	8.3	4.1	8.1	13.6	17.1	0.3
Perimeter 12	**56.3**	**1329.3**	**59.7**	**24.3**	**86.2**	**127.9**	**135.8**	**8.6**
NE Texas	**16.4**	**4348.6**	**78.6**	**31.7**	**108.9**	**197.1**	**238.5**	**19.3**
HGBPA	**19.6**	**1548.8**	**161.2**	**85.3**	**159.5**	**507.6**	**310.7**	**102.6**
East Central TX	**111.2**	**5430.8**	**77.9**	**36.1**	**115.8**	**189.7**	**238.6**	**24.3**
OK	**224.1**	**6866.5**	**265.4**	**173.4**	**332.9**	**355.2**	**583.4**	**95.0**
AR	**133.6**	**12293.3**	**198.0**	**114.9**	**342.2**	**420.3**	**337.7**	**49.6**
LA	**108.3**	**8378.3**	**265.0**	**151.0**	**1139.1**	**571.9**	**868.2**	**56.3**
NNA	**220.4**	**1851.7**	**194.8**	**113.5**	**217.2**	**450.4**	**318.1**	**22.0**
Other TX	**508.4**	**5370.8**	**128.1**	**74.1**	**386.1**	**591.5**	**209.8**	**14.7**
Other	**1977.8**	**64264.8**	**2549.3**	**1488.7**	**3871.8**	**4623.5**	**5805.8**	**854.5**
Total	**3402.4**	**111900.1**	**4163.4**	**2384.0**	**6942.3**	**8282.0**	**9076.7**	**1254.4**

* Other anthropogenic emissions are area sources plus off-road mobile sources.

Table 2-6. Summary of 1999 model ready emissions for Tuesday August 17th by source region and category.

Source	Biogenic		On-road Mobile		Other Anthropogenic*		Major Point	
Region	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC
Colin Co.	11.2	29.0	29.2	13.7	24.1	24.4	5.2	0.2
Dallas Co.	4.2	56.2	179.3	76.0	83.5	125.1	60.1	4.6
Denton Co.	8.1	66.4	36.0	15.0	18.8	21.3	5.2	1.3
Tarrant Co.	2.9	65.5	118.2	47.6	64.8	90.2	39.7	4.6
Core	**26.4**	**217.2**	**362.7**	**152.4**	**191.1**	**261.0**	**110.3**	**10.8**
Wise Co.	2.3	149.5	4.9	3.1	34.3	21.6	10.3	0.6
Parker Co.	0.6	130.9	13.5	4.3	16.7	12.3	3.9	0.3
Hood Co.	0.2	34.5	2.1	1.2	3.8	4.6	30.1	0.3
Johnson Co.	4.8	108.3	11.6	4.7	9.2	11.2	6.0	0.4
Ellis Co.	14.3	89.7	19.5	4.7	7.9	12.1	29.8	4.1
Henderson Co.	0.7	275.5	5.8	3.5	9.1	12.4	5.3	0.2
Cooke Co.	3.7	88.5	4.2	2.7	3.2	11.8	0.0	0.0
Kaufman Co.	5.0	105.8	12.6	4.6	5.0	10.8	0.0	0.2
Rockwall Co.	1.6	3.6	4.4	1.7	0.9	2.9	0.0	0.0
Hunt Co.	6.8	77.2	11.1	4.0	3.3	10.3	0.6	0.1
Fannin Co.	7.1	120.9	1.6	1.1	1.9	4.7	0.0	0.0
Grayson Co.	9.1	144.8	11.5	7.3	10.0	14.4	23.3	0.3
Perimeter 12	**56.3**	**1329.3**	**102.7**	**42.9**	**105.4**	**129.1**	**109.3**	**6.5**
NE Texas	**16.4**	**4348.6**	**103.8**	**63.2**	**150.0**	**204.1**	**348.9**	**21.6**
HGBPA	**19.6**	**1548.8**	**269.0**	**173.8**	**272.7**	**479.7**	**684.0**	**70.9**
East Central TX	**111.2**	**5430.8**	**113.6**	**67.7**	**150.1**	**194.8**	**331.3**	**26.5**
OK	**224.1**	**6866.5**	**392.9**	**427.6**	**447.6**	**487.1**	**617.7**	**30.8**
AR	**133.6**	**12293.3**	**288.3**	**197.1**	**376.0**	**518.1**	**391.4**	**53.4**
LA	**108.3**	**8378.3**	**389.6**	**257.8**	**1101.0**	**748.0**	**1642.6**	**135.3**
NNA	**220.4**	**1851.7**	**101.8**	**63.9**	**267.2**	**470.6**	**445.0**	**25.1**
Other TX	**508.4**	**5370.8**	**171.1**	**126.7**	**439.4**	**623.8**	**273.8**	**13.9**
Other	**1977.8**	**64264.8**	**3691.0**	**2558.7**	**4437.2**	**6666.1**	**10682.4**	**651.6**
Total	**3402.4**	**111900.1**	**5986.8**	**4131.8**	**7937.7**	**10782.4**	**15636.8**	**1046.2**

* Other anthropogenic emissions are area sources plus off-road mobile sources.

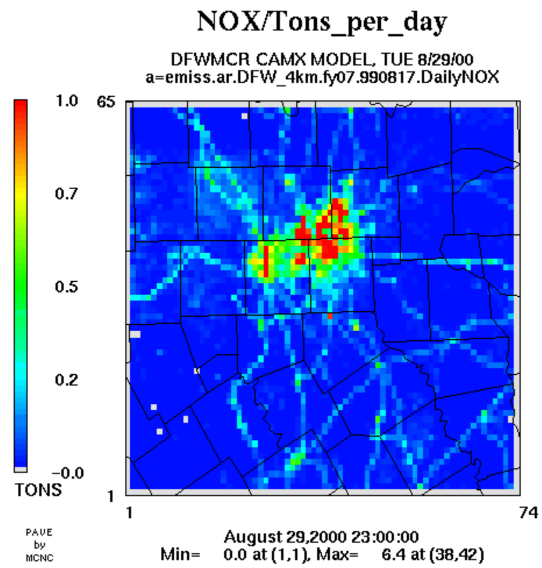
Table 2-7. Ratio of 2007 to 1999 model ready emissions for Tuesday August 17th by source region and category.

Source	Biogenic		On-road Mobile		Other Anthropogenic*		Major Point	
Region	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**
Colin Co.	1.00	1.00	0.56	0.63	0.87	0.92	0.58	0.96
Dallas Co.	1.00	1.00	0.50	0.58	0.98	0.90	0.25	0.90
Denton Co.	1.00	1.00	0.55	0.62	0.66	1.12	0.48	0.76
Tarrant Co.	1.00	1.00	0.51	0.60	1.04	0.97	0.24	0.45
Core	**1.00**	**1.00**	**0.51**	**0.60**	**0.96**	**0.95**	**0.27**	**0.69**
Wise Co.	1.00	1.00	0.63	0.54	0.59	0.92	0.87	1.32
Parker Co.	1.00	1.00	0.54	0.53	0.52	0.87	1.61	1.64
Hood Co.	1.00	1.00	0.60	0.66	0.51	0.84	0.69	1.99
Johnson Co.	1.00	1.00	0.54	0.57	0.99	0.99	0.70	0.54
Ellis Co.	1.00	1.00	0.51	0.54	2.39	1.34	2.18	1.06
Henderson Co.	1.00	1.00	0.56	0.60	0.64	0.96	1.07	0.99
Cooke Co.	1.00	1.00	0.73	0.58	0.95	0.88	1.00	1.00
Kaufman Co.	1.00	1.00	0.57	0.56	0.90	1.05	679.35	9.82
Rockwall Co.	1.00	1.00	0.75	0.52	1.44	1.02	1.00	1.00
Hunt Co.	1.00	1.00	0.51	0.60	0.87	1.12	0.39	0.88
Fannin Co.	1.00	1.00	0.72	0.60	0.81	0.94	1.00	0.76
Grayson Co.	1.00	1.00	0.73	0.57	0.81	0.94	0.73	1.00
Perimeter 12	**1.00**	**1.00**	**0.58**	**0.57**	**0.82**	**0.99**	**1.24**	**1.33**
NE Texas	**1.00**	**1.00**	**0.76**	**0.50**	**0.73**	**0.97**	**0.68**	**0.89**
HGBPA	**1.00**	**1.00**	**0.60**	**0.49**	**0.58**	**1.06**	**0.45**	**1.45**
East Central TX	**1.00**	**1.00**	**0.69**	**0.53**	**0.77**	**0.97**	**0.72**	**0.92**
OK	**1.00**	**1.00**	**0.68**	**0.41**	**0.74**	**0.73**	**0.94**	**3.09**
AR	**1.00**	**1.00**	**0.69**	**0.58**	**0.91**	**0.81**	**0.86**	**0.93**
LA	**1.00**	**1.00**	**0.68**	**0.59**	**1.03**	**0.76**	**0.53**	**0.42**
NNA	**1.00**	**1.00**	**1.91**	**1.78**	**0.81**	**0.96**	**0.71**	**0.88**
Other TX	**1.00**	**1.00**	**0.75**	**0.58**	**0.88**	**0.95**	**0.77**	**1.06**
Other	**1.00**	**1.00**	**0.69**	**0.58**	**0.87**	**0.69**	**0.54**	**1.31**
Total	**1.00**	**1.00**	**0.70**	**0.58**	**0.87**	**0.77**	**0.58**	**1.20**

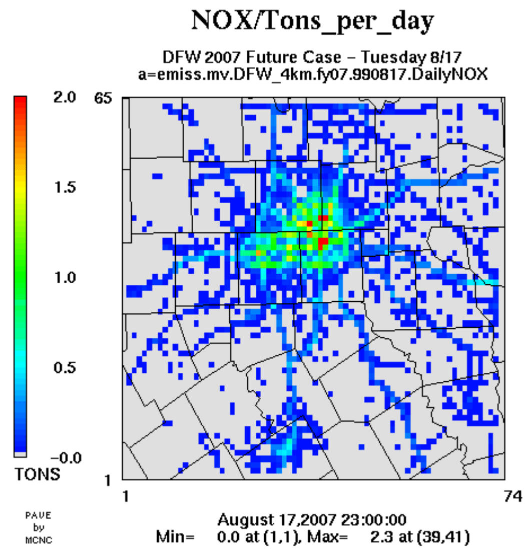
* Other anthropogenic emissions are area sources plus off-road mobile sources.

Table 2-8. Emissions source area definitions.

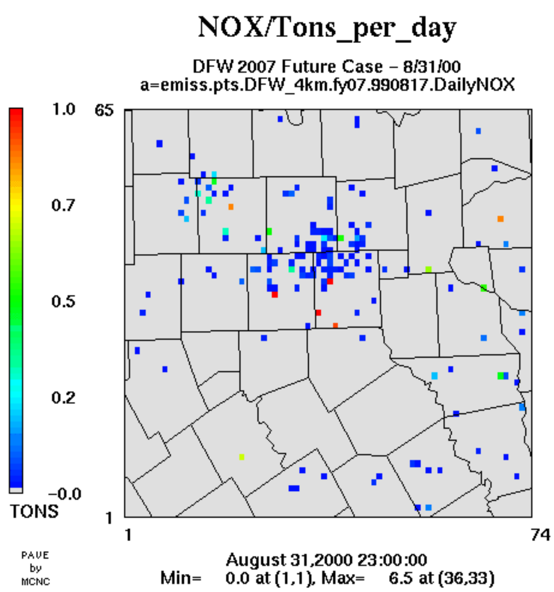
Area Number	Area Abbreviation	Area Definition
1-4	Core	Dallas Core Counties (Collin, Dallas, Denton, Tarrant)
5-16	Perimeter12	12 Counties surrounding Dallas Core (Wise, Parker, Hood Johnson, Ellis, Henderson, Cooke, Kaufman, Rockwall, Hunt, Fannin, Grayson)
17	East Texas	Northeast Texas
18	HGBPA	Houston/Galveston/Beaumont/Port-Arthur (11 Counties)
19	Central Texas	East Central Texas
20	OK	Oklahoma
21	AR	Arkansas
22	LA	Louisiana
23	South Texas	Near Non-attainment areas (Austin, San Antonio, Victoria, Corpus Christi)
24	West Texas	Texas (excluding area 1-19 and 23
25	Other States	Other areas



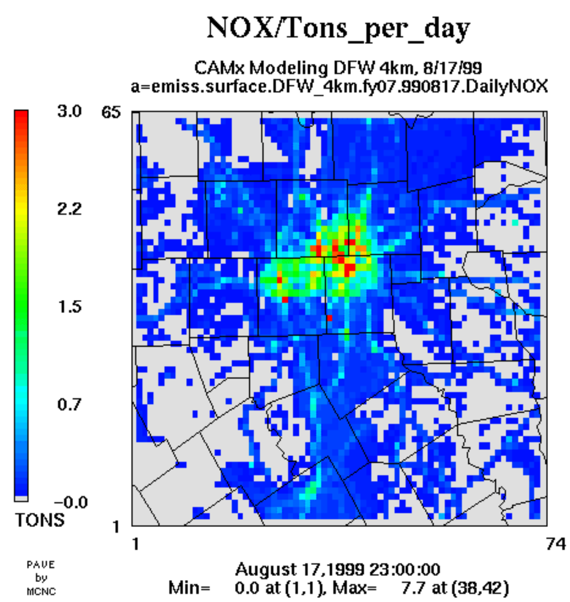
Area and Off-road NOx emissions



On-road mobile NOx emissions



Low-level point source NOx emissions



Total merged surface NOx emissions

Figure 2-2. 2007 NOx emissions for Tuesday August 17th on the 4-km grid.

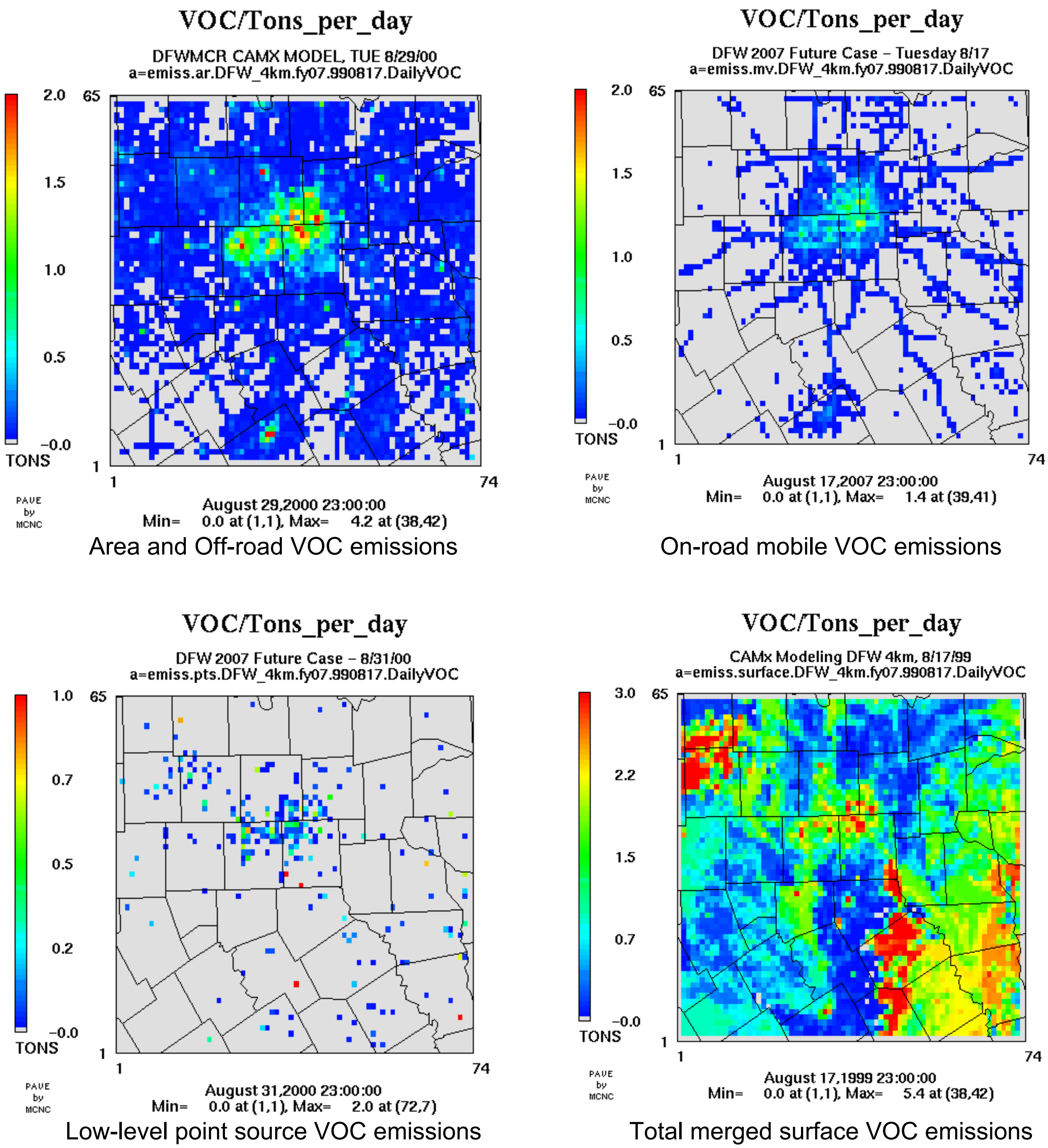
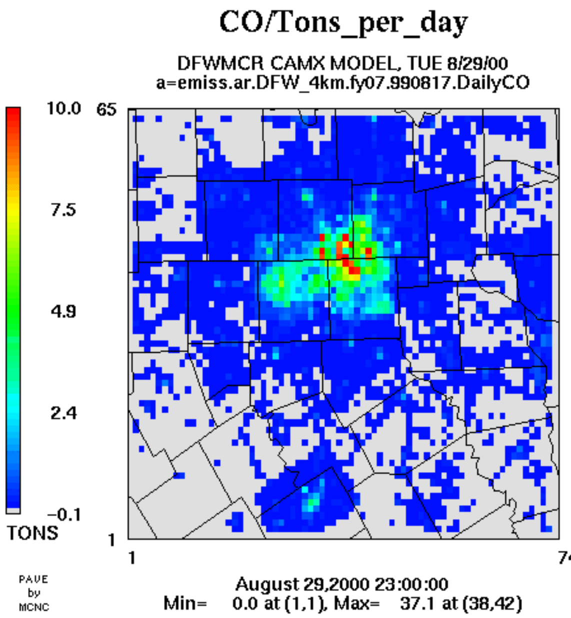
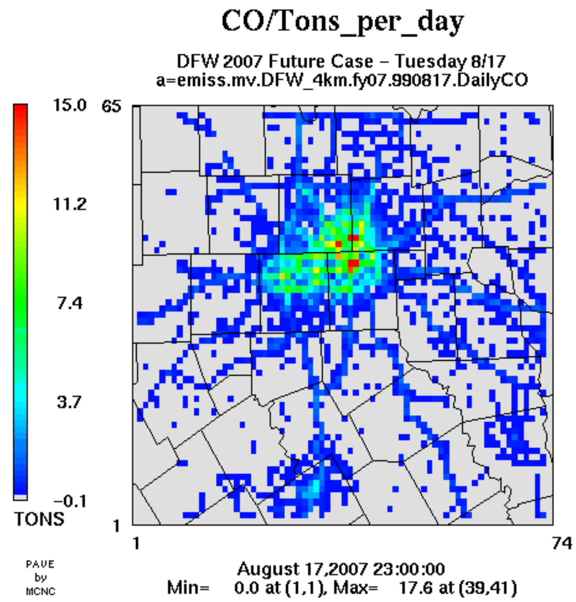


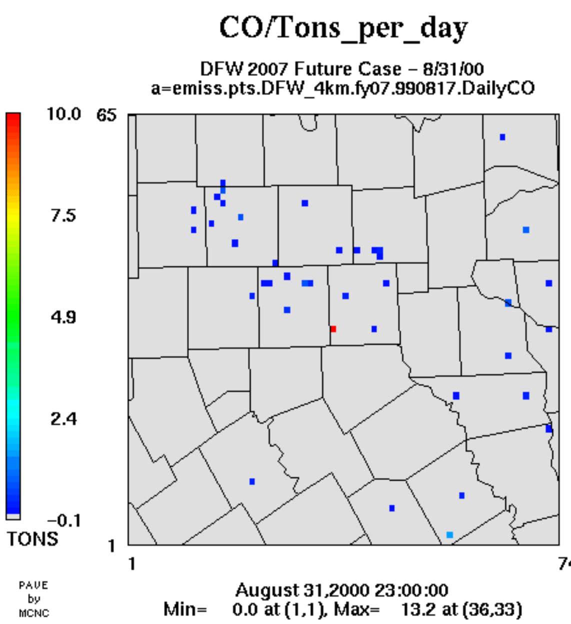
Figure 2-3. 2007 VOC emissions for Tuesday August 17th on the 4-km grid.



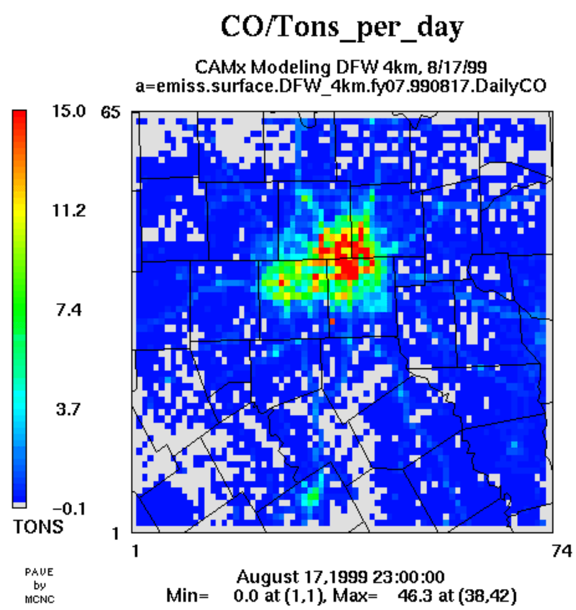
Area and Off-road CO emissions



On-road mobile CO emissions



Low-level point source CO emissions



Total merged surface CO emissions

Figure 2-4. 2007 CO emissions for Tuesday August 17th on the 4-km grid.

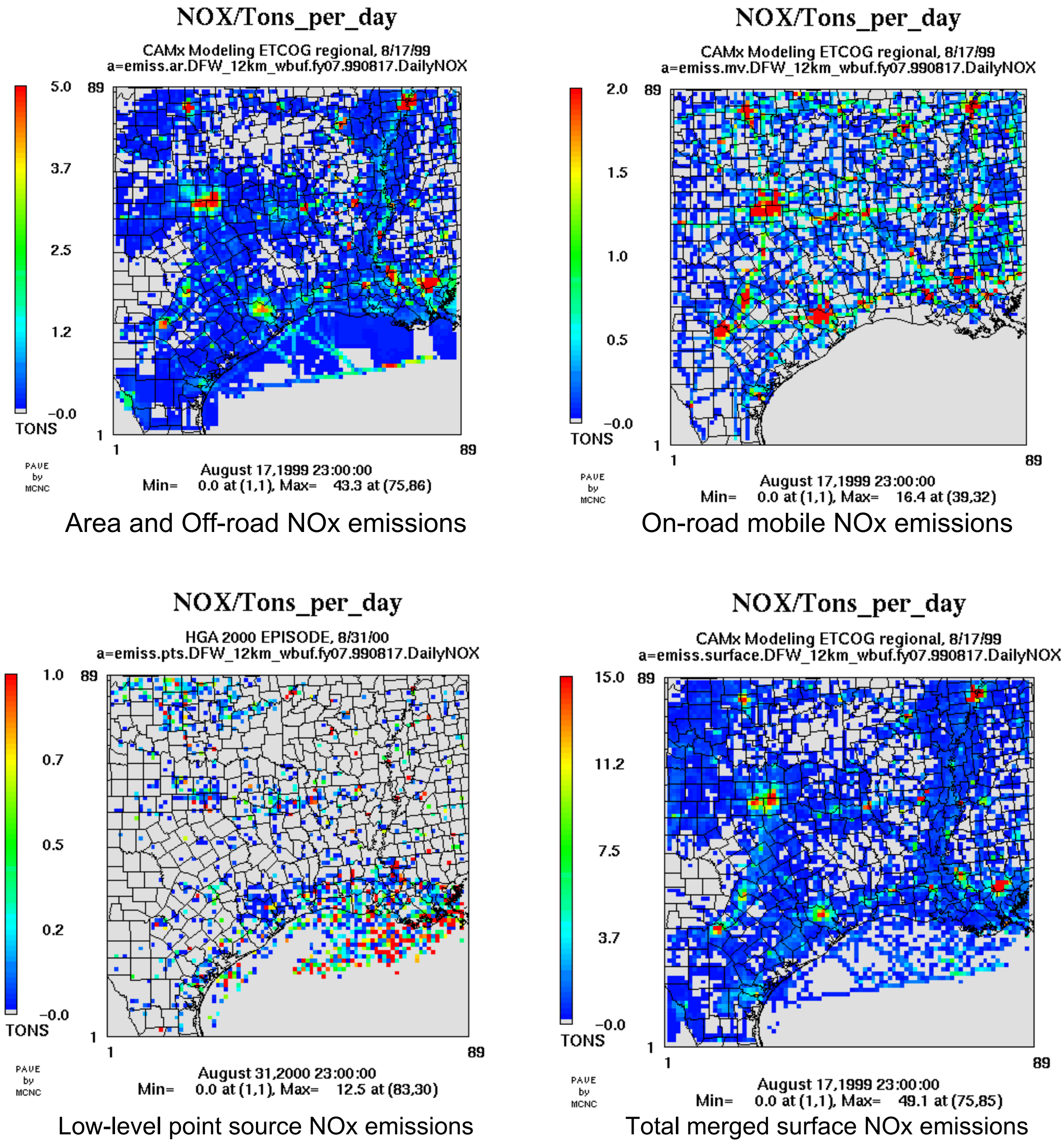
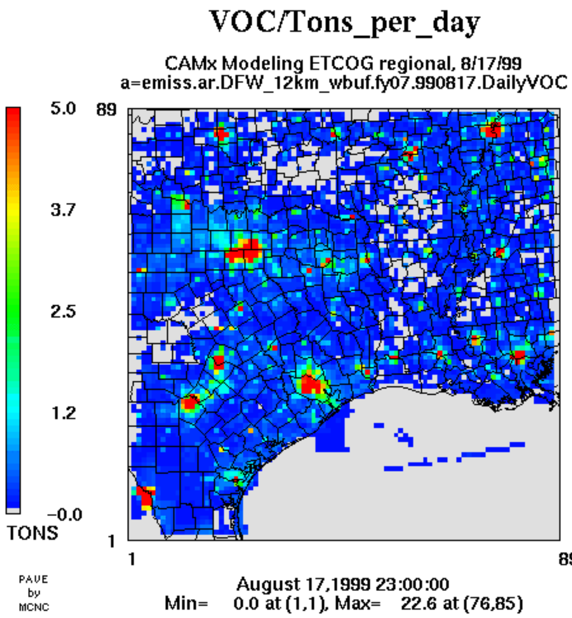
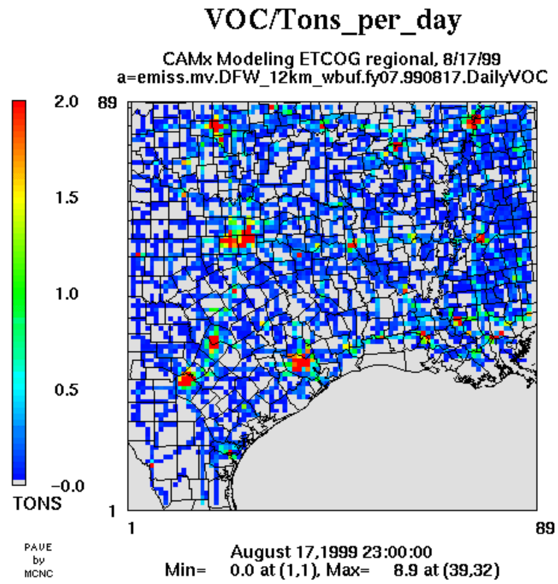


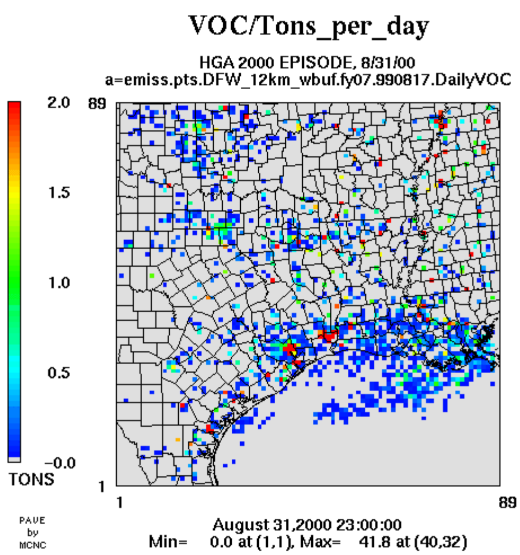
Figure 2-5. 2007 NOx emissions for Tuesday August 17th on the 12-km emissions grid.



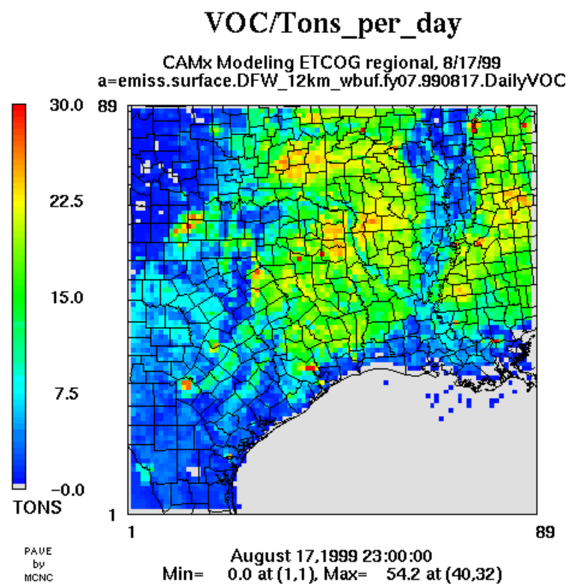
Area and Off-road VOC emissions



On-road mobile VOC emissions

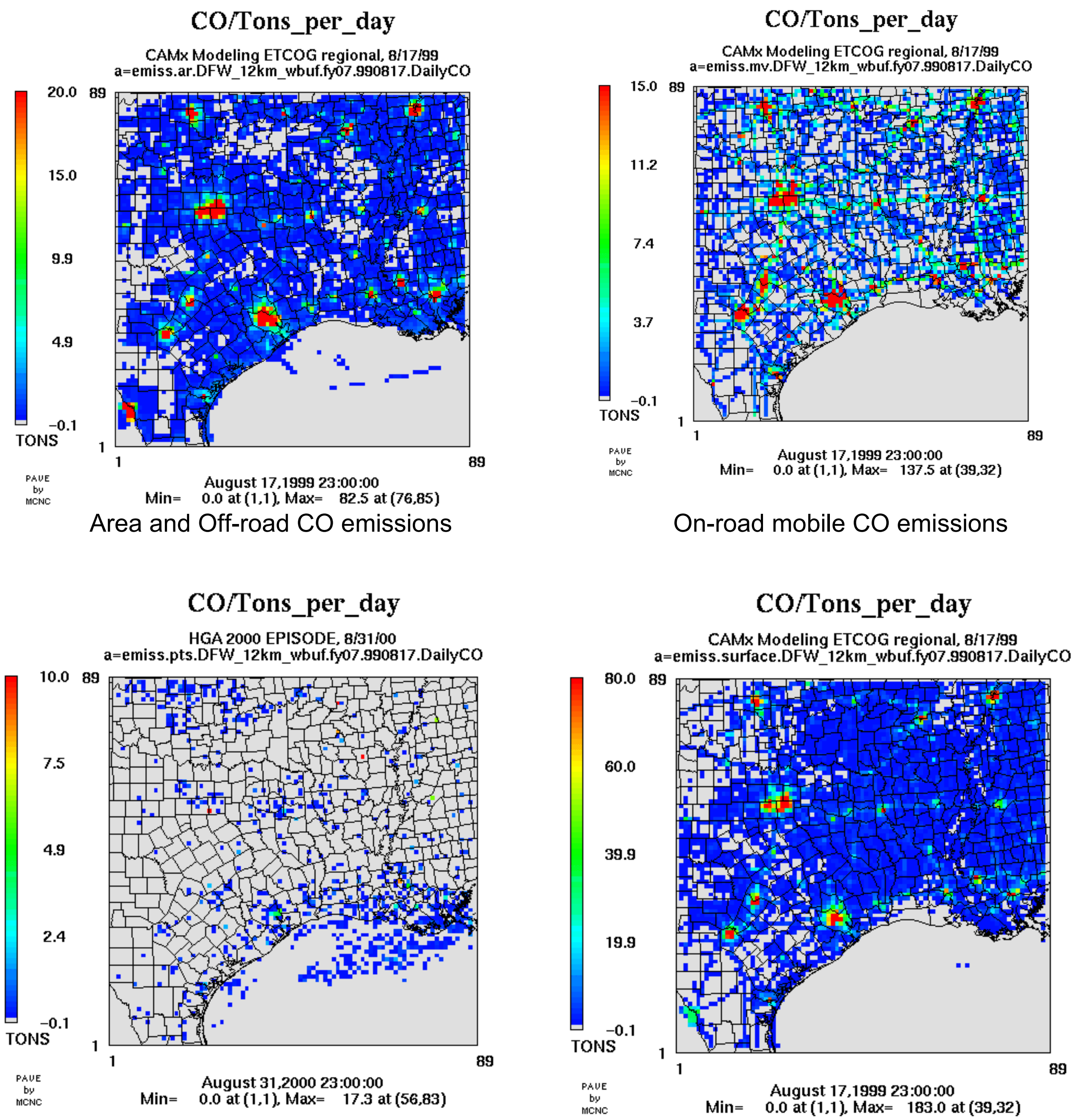


Low-level point source VOC emissions



Total merged surface VOC emissions

Figure 2-6. 2007 VOC emissions for Tuesday August 17th on the 12-km emissions grid.



Area and Off-road CO emissions

On-road mobile CO emissions

Low-level point source CO emissions

Total merged surface CO emissions

Figure 2-7. 2007 CO emissions for Tuesday August 17th on the 12-km emissions grid.

3.0 OZONE MODELING

CAMx MODEL CONFIGURATION AND INPUTS

Previous CAMx modeling of the Dallas/Fort Worth August 1999 ozone episode described by Mansell et al. (2003) used version 4.02 of the CAMx model. The current 2007 future year modeling uses CAMx version 4.03. CAMx 4.03 includes only a few changes from CAMx 4.02 (see the model release notes posted at http://www.camx.com), but one change corrects an error in the calculation of dry deposition velocities and results in slightly lower ozone levels (a few ppb) with CAMx 4.03 than CAMx 4.02 for the DFW modeling. The 1999 base year modeling was re-run with CAMx 4.03 to provide consistent base and future year simulation results for subsequent analysis. The input data requirements are the same for CAMx versions 4.02 and 4.03 so that updating the 1999 modeling to the new CAMx version does not require any changes to input data or files.

All of the CAMx meteorological input data were derived from the Fifth Generation Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Model (MM5; Duhdia, 1993). The MM5 modeling used nested 108-km, 36-km, 12-km and 4-km grids and 28 vertical layers. An analysis of the final MM5 run used for air quality modeling of the DFW 1999 episode (denoted Run3), is documented in ENVIRON, 2003, and Mansell et al., (2003).

CAMx has several user-selectable options that are specified for each simulation through the CAMx control file. Most of these options follow naturally from other choices about model inputs. There are four model options that must be decided for each project: the choice of the chemical mechanism, the chemistry solver, advection scheme, and the plume-in-grid scheme. The selection for each option is decided at the stage of the base case model performance evaluation and then held fixed for the evaluation of any future year emission scenarios. The CAMx model configuration and inputs used for both the 1999 and 2007 modeling were documented in Mansell, et al., (2003), and briefly summarized below.

Chemistry Data

The chemistry parameters file specifies the photochemical mechanism used to model ozone formation as well as the rates for all thermo-chemical reactions associated with the chemical mechanism.

- CAMx was run with an updated version of the Carbon Bond 4 mechanism (CB4), referred to as mechanism 3 in CAMx, which is described in the CAMx User's Guide (ENVIRON, 2002). Mechanism 3 is the CB4 mechanism with updated radical-radical termination reactions and updated isoprene mechanism as used for the OTAG modeling and other TCEQ modeling studies.

- CAMx has two options for the numerical scheme used to solve the chemical mechanism. The first option is the CMC fast solver that has been used in every prior version of CAMx. The second option is an IEH solver. The CMC solver is faster and more accurate than most chemistry solvers used for ozone modeling. The IEH solver is even more accurate than the CMC solver, but slower. The CMC solver was used for this study.

- The CB4 mechanism also includes several "photolysis" reactions that depend upon the presence of sunlight. The photolysis rates input file determines the rates for chemical reactions in the mechanism that are driven by sunlight. Photolysis rates were calculated using the Tropospheric visible Ultra-Violet (TUV) model developed by the National Center for Atmospheric Research (Madronich, 1993 and 2002). TUV is a state-of-the-science solar radiation model that is designed for photolysis rate calculations. TUV accounts for environmental parameters that influence photolysis rates including solar zenith angle, altitude above the ground, surface UV albedo, aerosols (haze), and stratospheric ozone column.

Advection Scheme

CAMx version 4.03 has three optional methods for calculating horizontal advection called Smolarkiewicz, Bott and Piecewise Parabolic Method (PPM). Although the Smolarkiewicz scheme has been used for many years, and was used in the previous modeling for Northeast Texas (ENVIRON, 1999), the scheme has been criticized for causing too much artificial diffusion of pollutants, tending to "smear out" features and artificially overstate transport. The Bott and PPM schemes are newer and have less artificial diffusion than the Smolarkiewicz scheme. The PPM scheme was used for this study as it has been determined to be the least numerically diffusive, runs at speeds similar to Smolarkiewicz, and does not exhibit certain "noisy" features near sharp gradients that are apparent with the Bott approach.

Plume-in-Grid

CAMx includes an optional sub-grid scale plume model that can be used to represent the dispersion and chemistry of major NOx point source plumes close to the source. We used the Plume-in-Grid (PiG) sub-model for major NOx sources (i.e., point sources with episode average NOx emissions greater than 2 tons per day in the 4-km grid and 2.5 tons per day outside the 4-km grid).

Surface Characteristics

CAMx requires gridded landuse data to characterize surface boundary conditions, such as surface roughness, deposition parameters, vegetative distribution, and water/land boundaries. CAMx land use files provide the fractional contribution (0 to 1) of eleven land use categories to the surface area of grid cell. Gridded land cover data were developed from the same landuse databases that were used in the generation of spatial emission surrogates for the 36-km and 12-km grids. The development of surface characteristics data was documented in Mansell et al. (2003)

Initial and Boundary Conditions

The initial conditions (ICs) are the pollutant concentrations specified throughout the modeling domain at the start of the simulation. Boundary conditions (BCs) are the pollutant concentrations specified at the perimeter of the modeling domain. Conventional wisdom dictates that the boundary conditions should have little impact on the model results for the DFW area because regional modeling is being performed. One of the reasons for performing regional scale modeling rather than urban scale modeling is to minimize the importance of ICs and BCs. Using a large regional domain moves the boundaries far away (in distance and transport time) from the study area.

However, the base case modeling and sensitivity tests (Mansell et al., 2003) showed that the boundary conditions do influence the modeling results for DFW non-attainment area. In particular, the amount of background VOC in air entering the modeling domain from the Midwest and Southeast influences the regional background ozone levels transported into DFW. The VOC boundary conditions are mainly influenced by biogenic emissions and so there is no reason to reduce the VOC boundary conditions from 1999 to 2007. The ozone boundary condition was set to 40 ppb for 1999 which is the commonly assumed default background level for ozone. The NOx boundary condition for 2007 was set to 1.1 ppb which is a low value representative of rural areas. Therefore, the 2007 boundary and initial conditions were not changed from the 1999 values described in Mansell et al. (2003).

UPDATED 1999 BASE CASE

Version 4.03 of the CAMx air quality model was run for the August 1999 Dallas/Ft. Worth ozone episode using the model configuration and input described above. Both the 1999 base and 2007 future years were simulated. The 1999 base year was re-run with CAMx 4.03 to provide a consistent set of modeling results for the design value scaling analysis.

OZONE MODELING RESULTS FOR 1999 AND 2007

Table 3-1 presents the one-hour ozone model performance statistics for the 1999 base year simulation (99run7c V4.03). The previous 1999 base case results (99run7c V4.02) are also shown for comparison. Model performance was slightly degraded from the CAMx 4.02 model results as discussed in more detail below. Also included in Table 3-1 are the observed and predicted daily maximum 1-hour ozone concentrations for the 1999 base case as well as the predicted daily maximum 1-hour ozone concentrations for the 2007 future year simulations (07run02). The results presented in Table 3-1 are for the DFW 4-km modeling domain.

Table 3-1. One-hour ozone model performance statistics on the DFW 4-km modeling domain.

		Episode Day							
		8/15/99	8/16/99	8/17/99	8/18/99	8/19/99	8/20/99	8/21/99	8/22/99
Peak Observed (ppb)									
		107.0	127.0	150.0	131.0	128.0	108.0	111.0	100.0
Peak Predicted (ppb)									
	99Run 7c (V4.02)	128.8	119.1	143.5	151.1	137.5	109.1	126.1	124.0
	99Run 7c (V4.03)	126.3	116.5	140.6	148.6	135.9	106.2	123.7	121.8
	07Run 02	105.8	120.9	138.5	138.3	125.4	96.4	105.7	94.0
Unpaired Accuracy of Peak (%) (EPA Goal ± 20%)									
	99Run 7c (V4.02)	20.4	-6.3	-4.3	15.3	7.5	1.0	13.6	24.0
	99Run 7c (V4.03)	18.0	-8.3	-6.3	13.4	6.2	-1.7	11.5	21.8
Normalized Bias (%) (EPA Goal ± 15%)									
	99Run 7c (V4.02)	-6.0	-14.3	-24.2	2.1	-5.4	-16.2	-21.9	-7.1
	99Run 7c (V4.03)	-10.1	-17.8	-27.1	-0.7	-7.7	-19.8	-25.6	-10.3
Normalized Gross Error (%) (EPA Goal 30 - 35%)									
	99Run 7c (V4.02)	19.4	16.6	27.0	11.8	14.0	17.1	22.8	19.6
	99Run 7c (V4.03)	20.0	19.1	29.1	10.9	14.5	20.1	26.1	19.9

Figures 3-1 and 3-2 present the spatial distribution of predicted 1-hour ozone concentrations within the DFW 4-km and regional 12-km modeling domains, respectively. Results for both the 1999 base and 2007 future year simulations are shown. Only the August 15 – 22 episode days are shown, as the first two days of the episode are considered “spin-up” days.

Corresponding displays for the predicted daily maximum 8-hour ozone concentrations are presented in Figures 3-3 and 3-4.

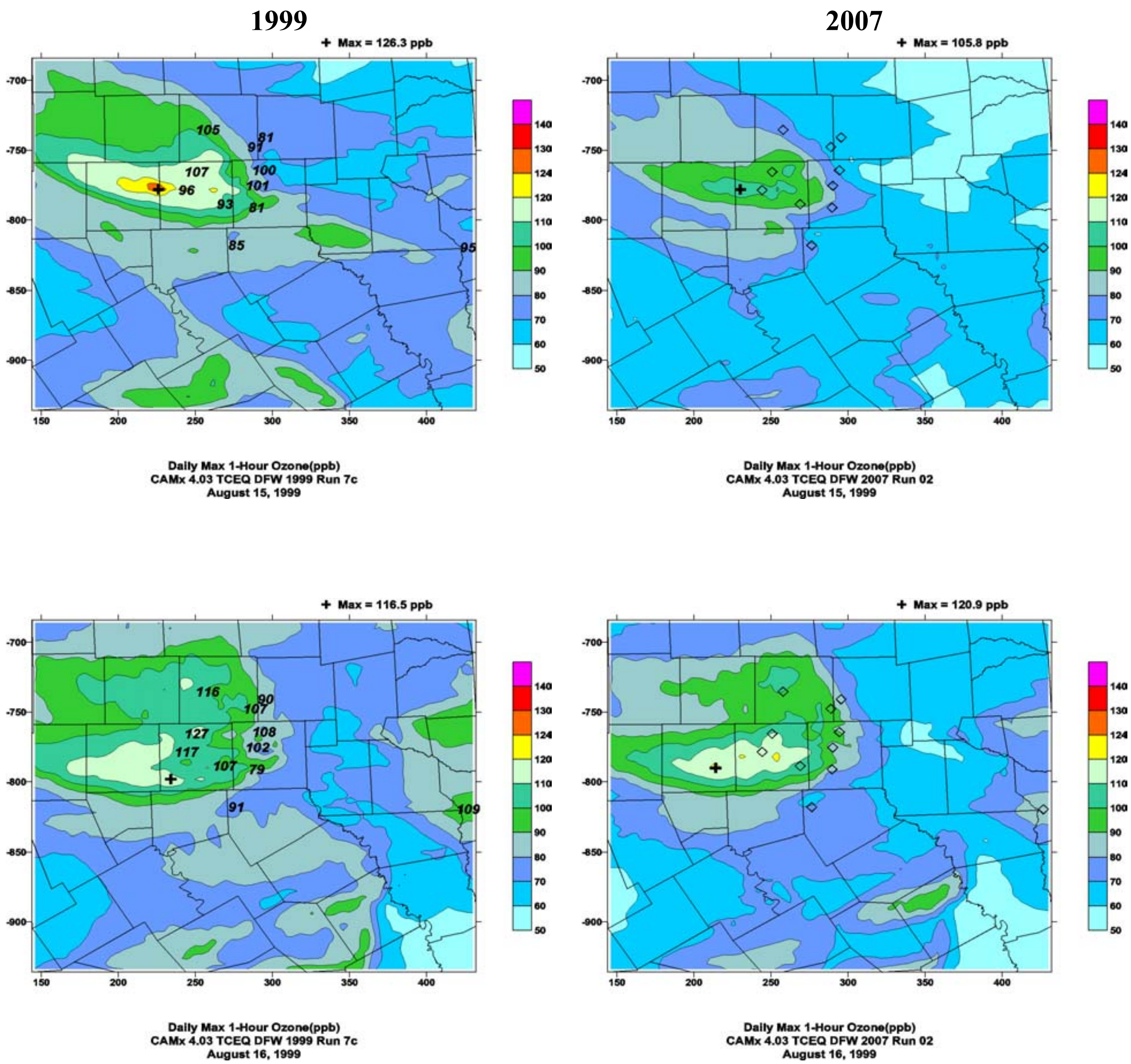


Figure 3-1. Daily maximum 1-hour ozone in the DFW 4-km domain for 1999 and 2007.

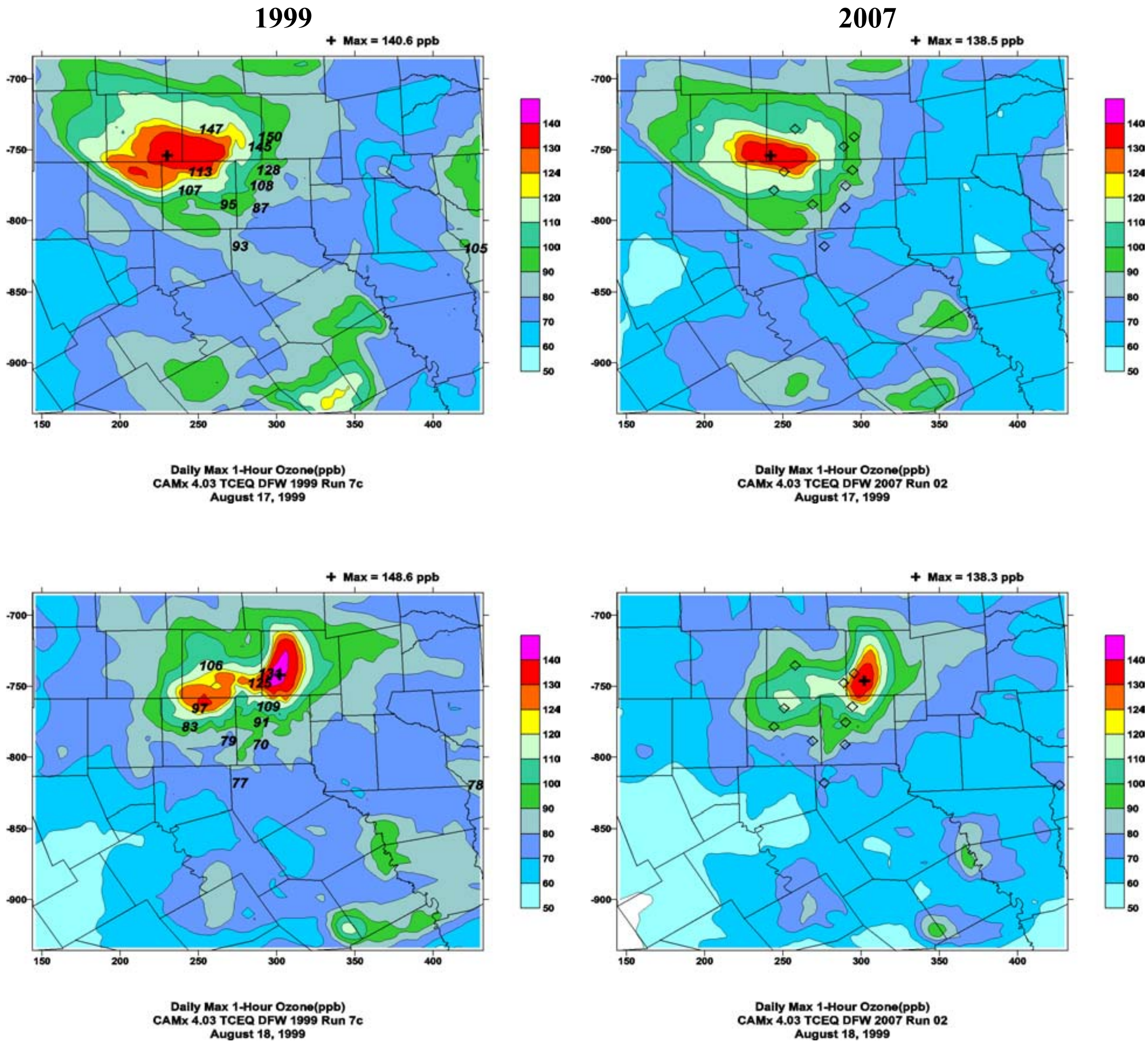


Figure 3-1 (cont). Daily maximum 1-hour ozone in the DFW 4-km domain for 1999 and 2007.

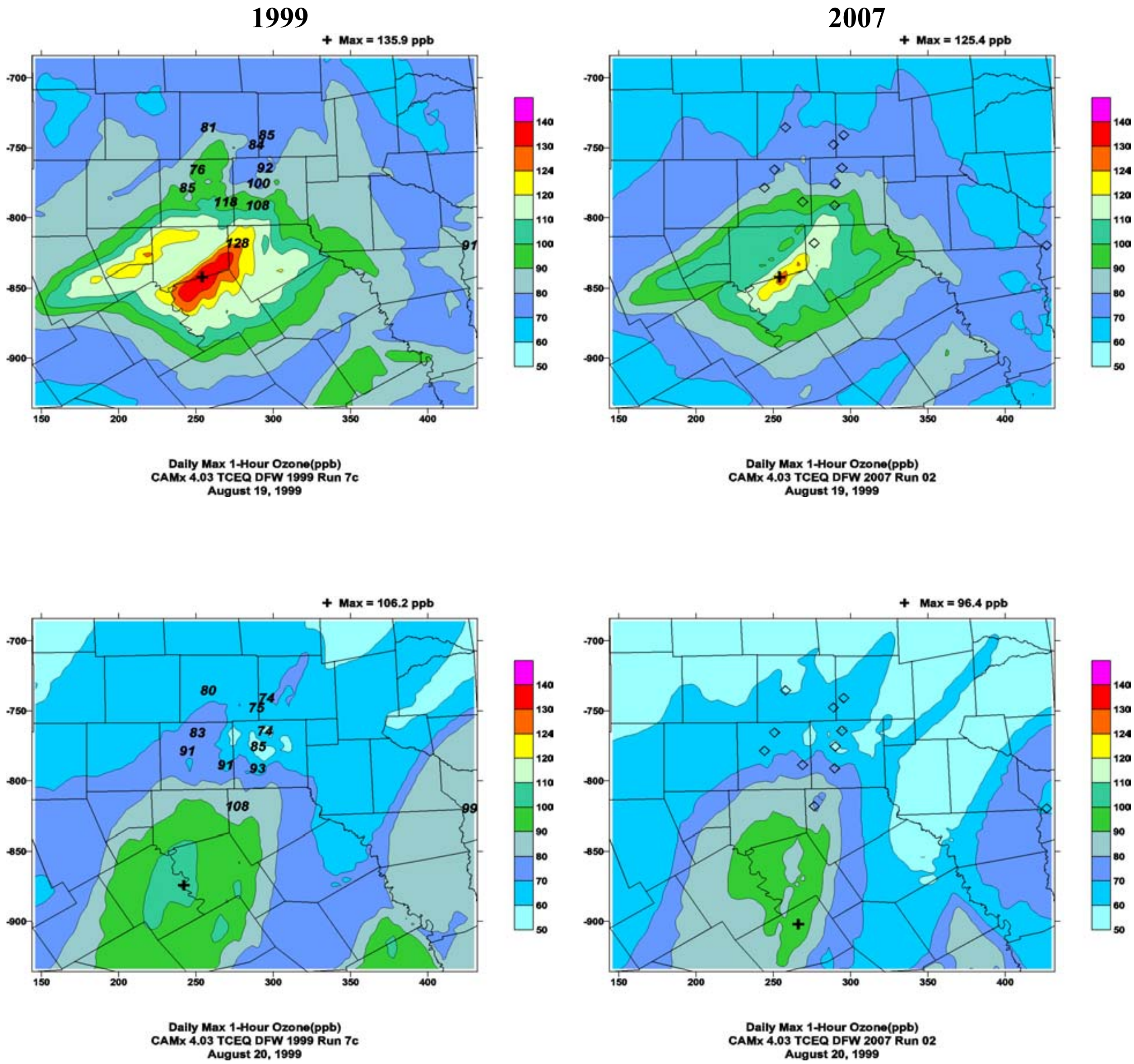


Figure 3-1 (cont). Daily maximum 1-hour ozone in the DFW 4-km domain for 1999 and 2007.

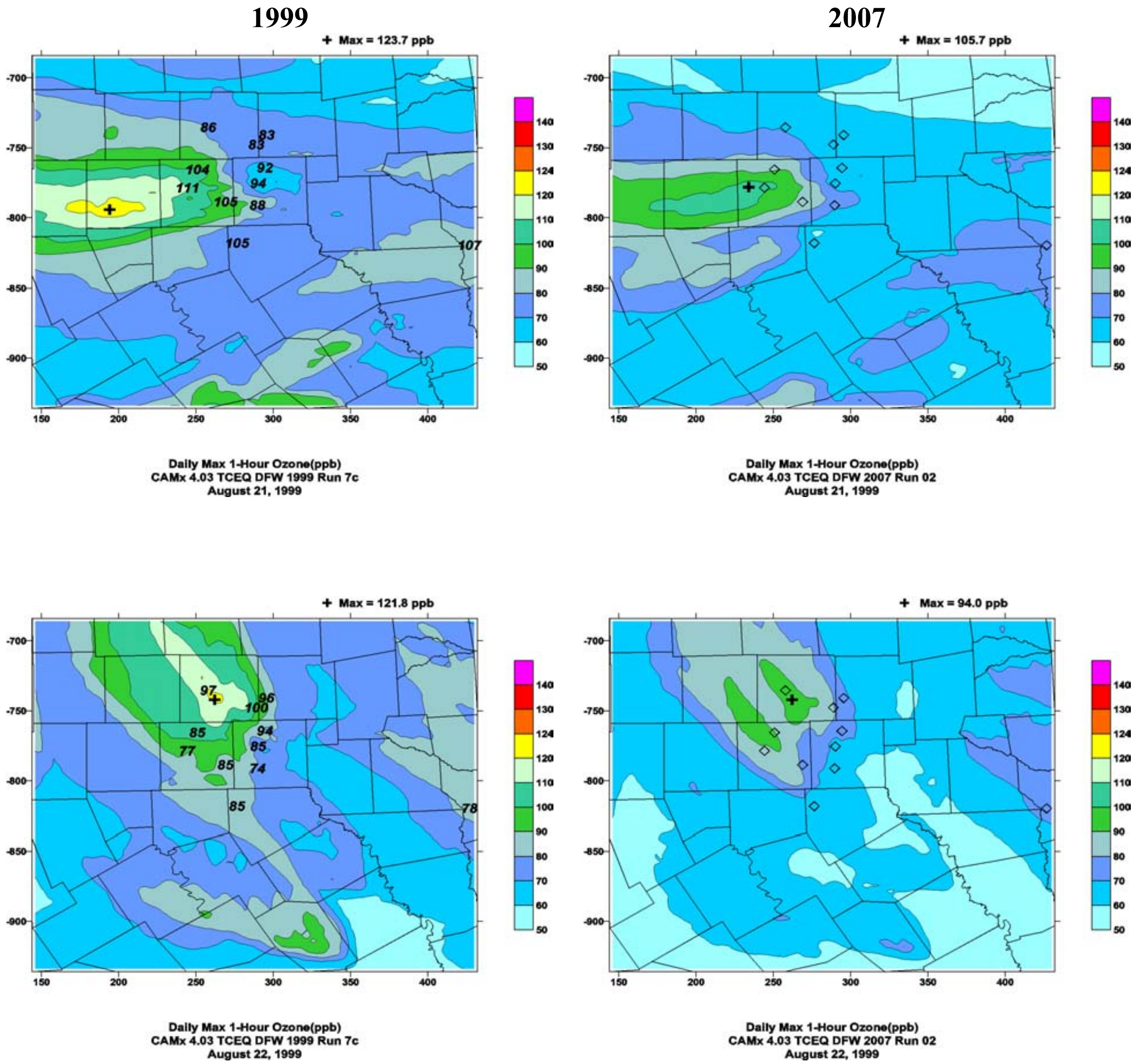


Figure 3-1 (concluded). Daily maximum 1-hour ozone in the DFW 4-km domain for 1999 and 2007.

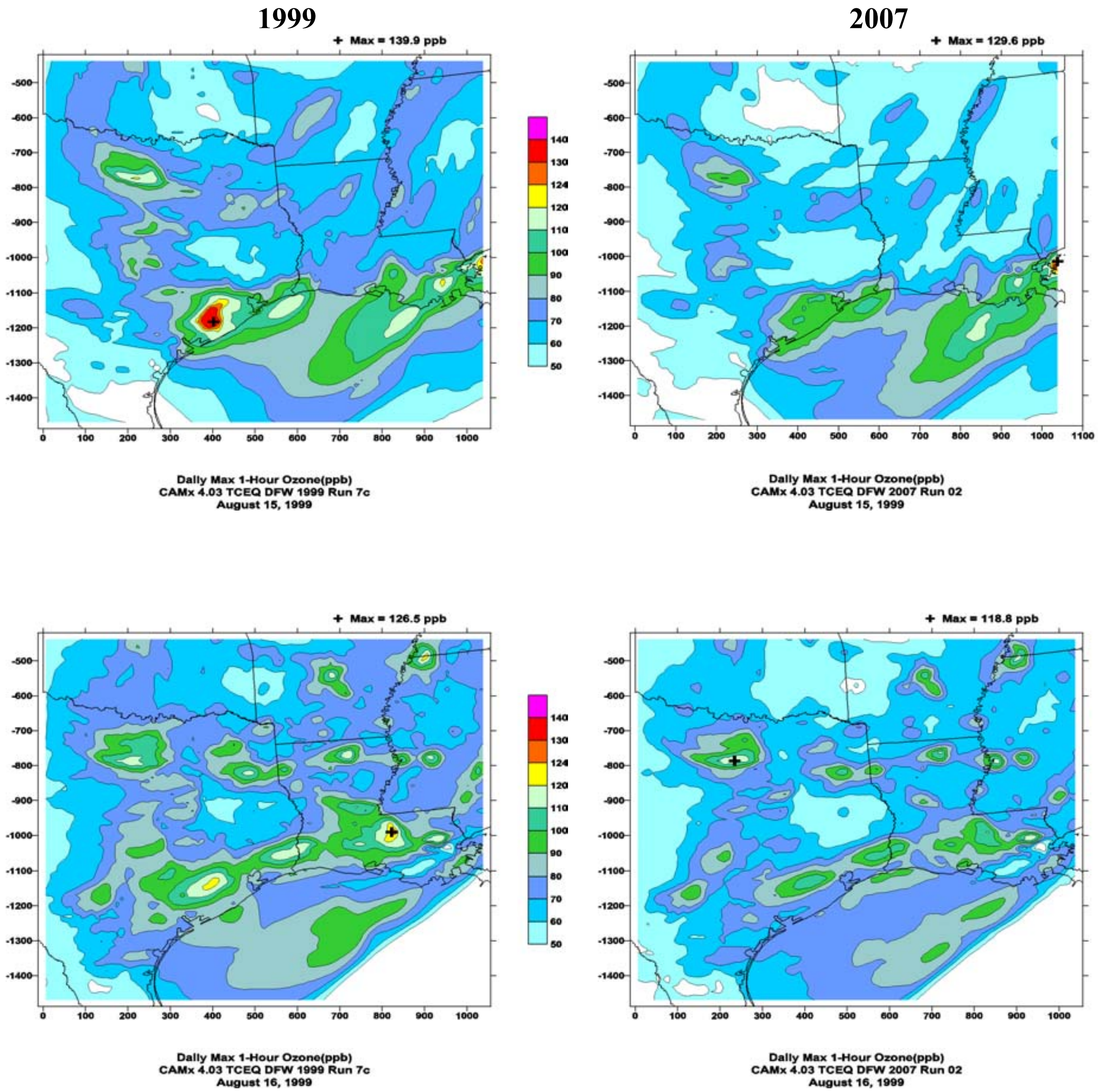


Figure 3-2. Daily maximum 1-hour ozone in the regional 12-km domain for 1999 and 2007.

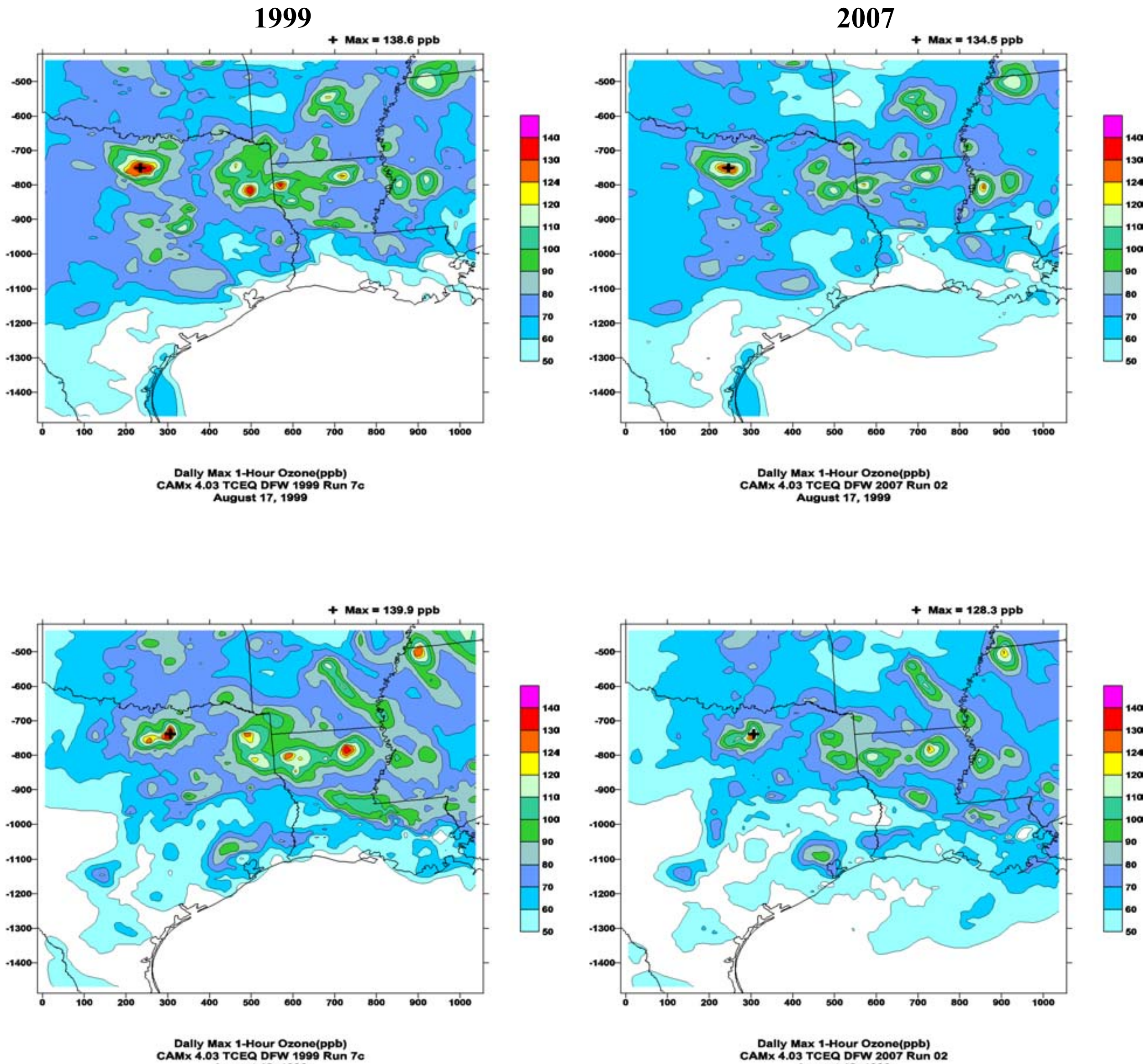


Figure 3-2 (cont.) Daily maximum 1-hour ozone in the regional 12-km domain for 1999 and 2007.

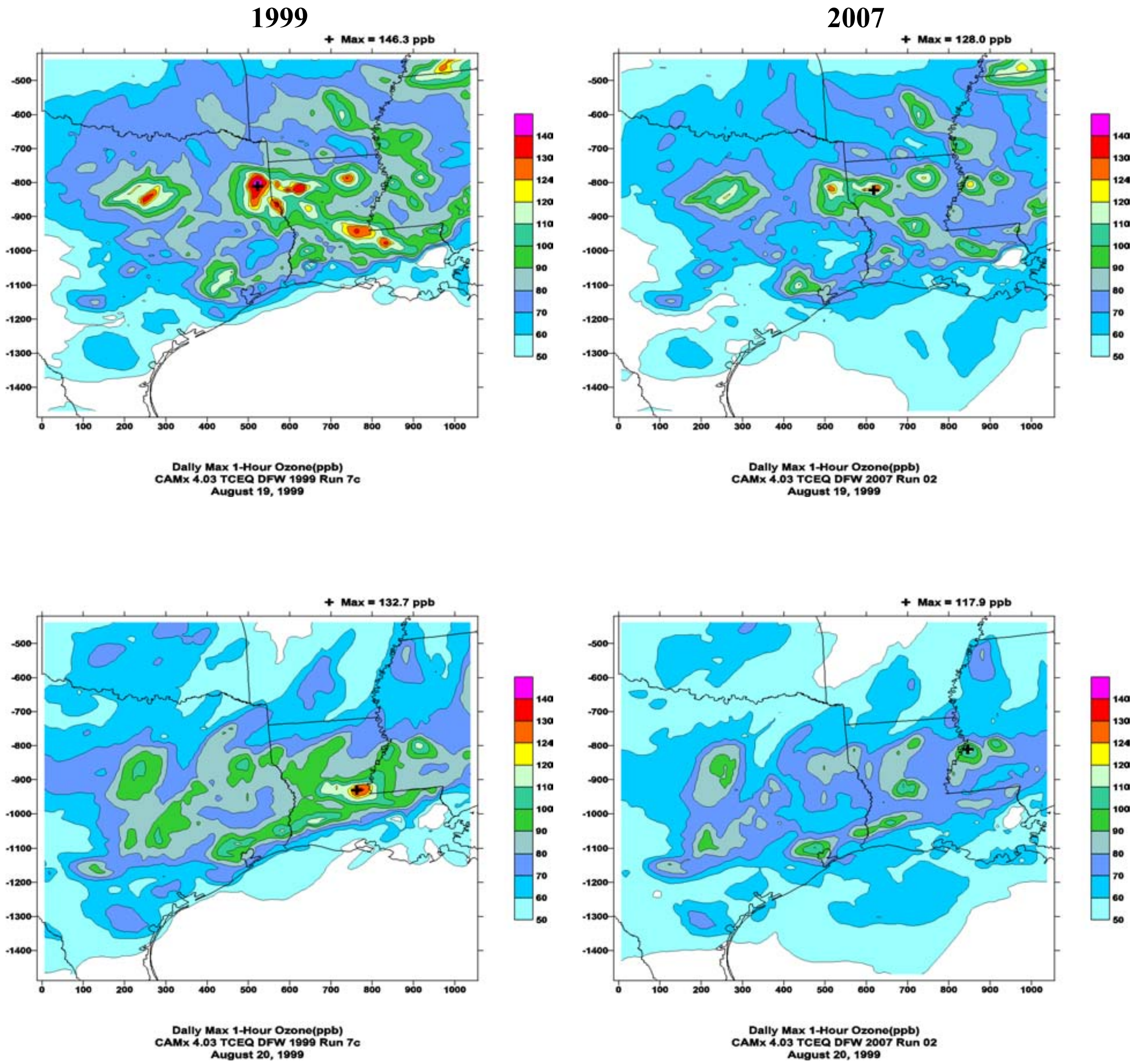


Figure 3-2 (cont.) Daily maximum 1-hour ozone in the regional 12-km domain for 1999 and 2007.

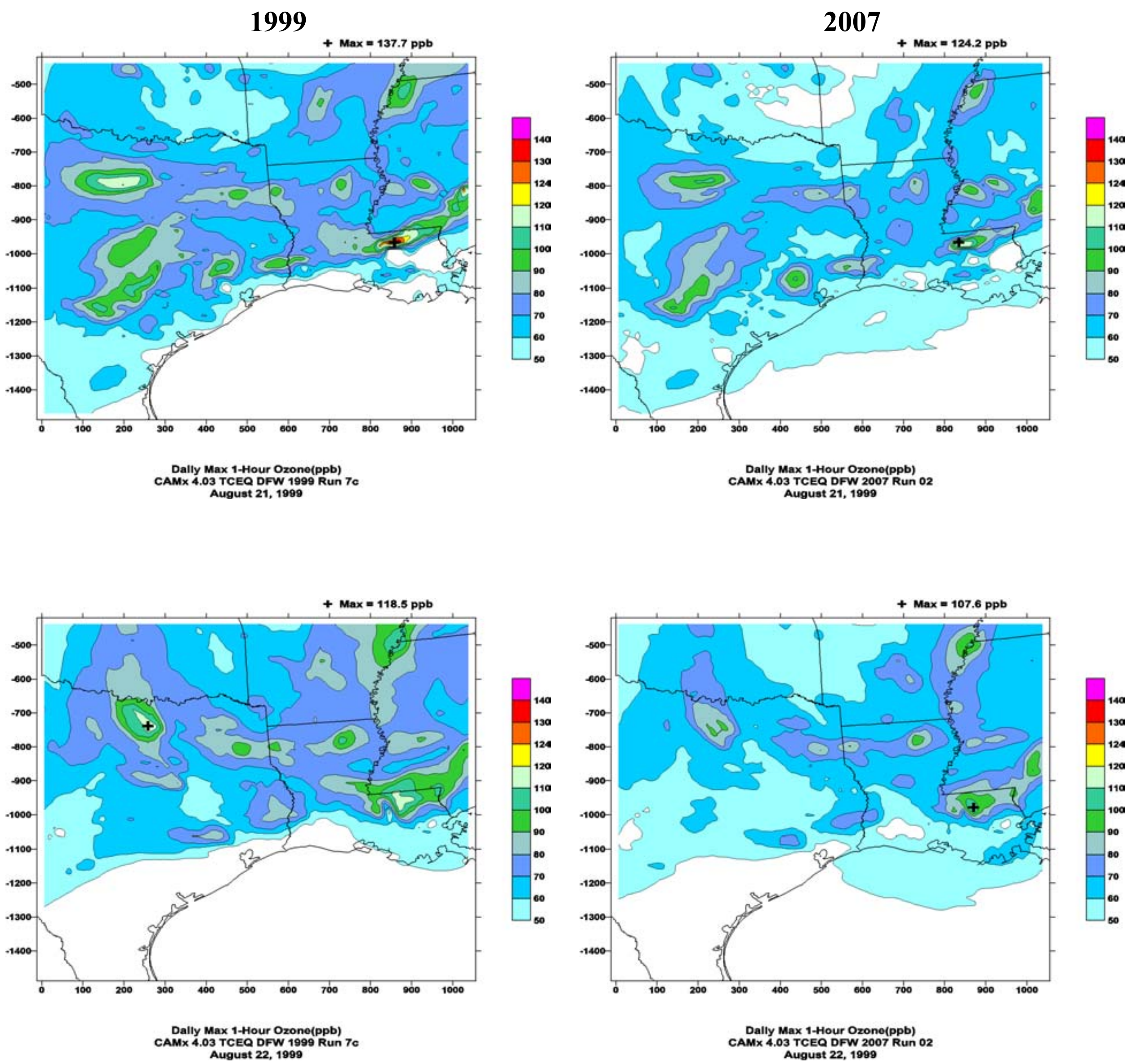


Figure 3-2 (concluded). Daily maximum 1-hour ozone in the regional 12-km domain for 1999 and 2007.

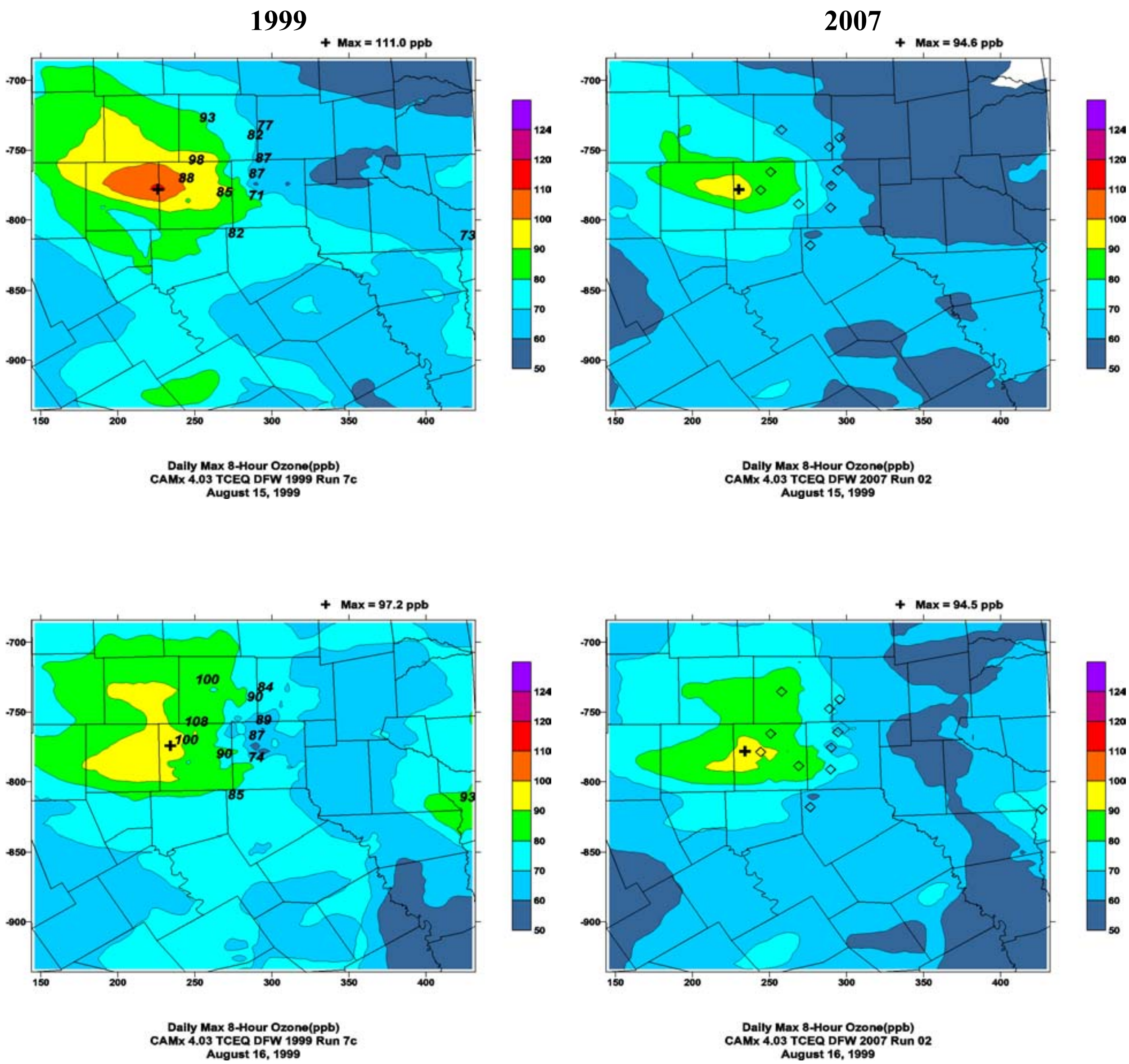


Figure 3-3. Daily maximum 8-hour ozone in the DFW 4-km domain for 1999 and 2007.

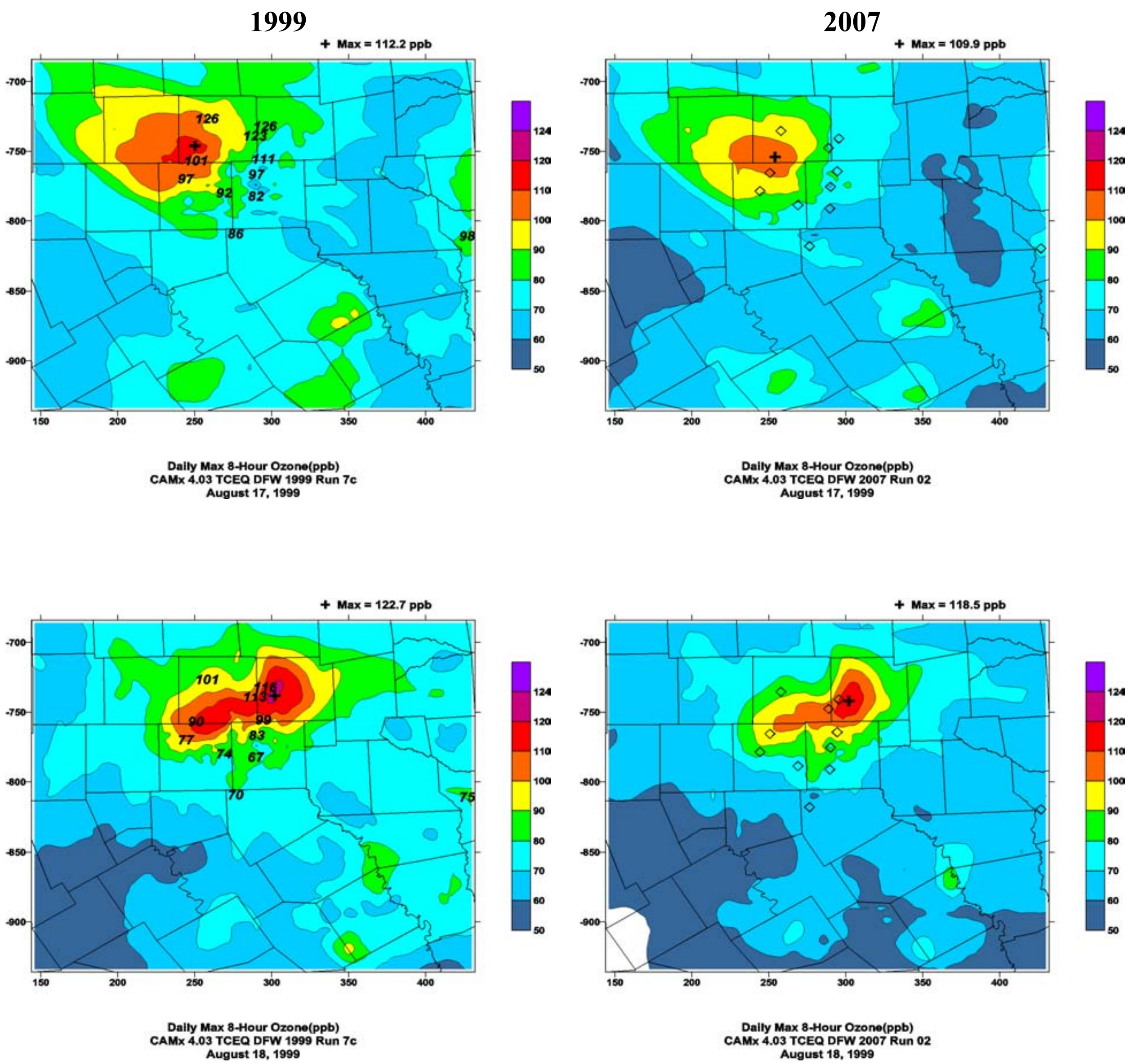


Figure 3- (cont.) Daily maximum 8-hour ozone in the DFW 4-km domain for 1999 and 2007.

1999 **2007**

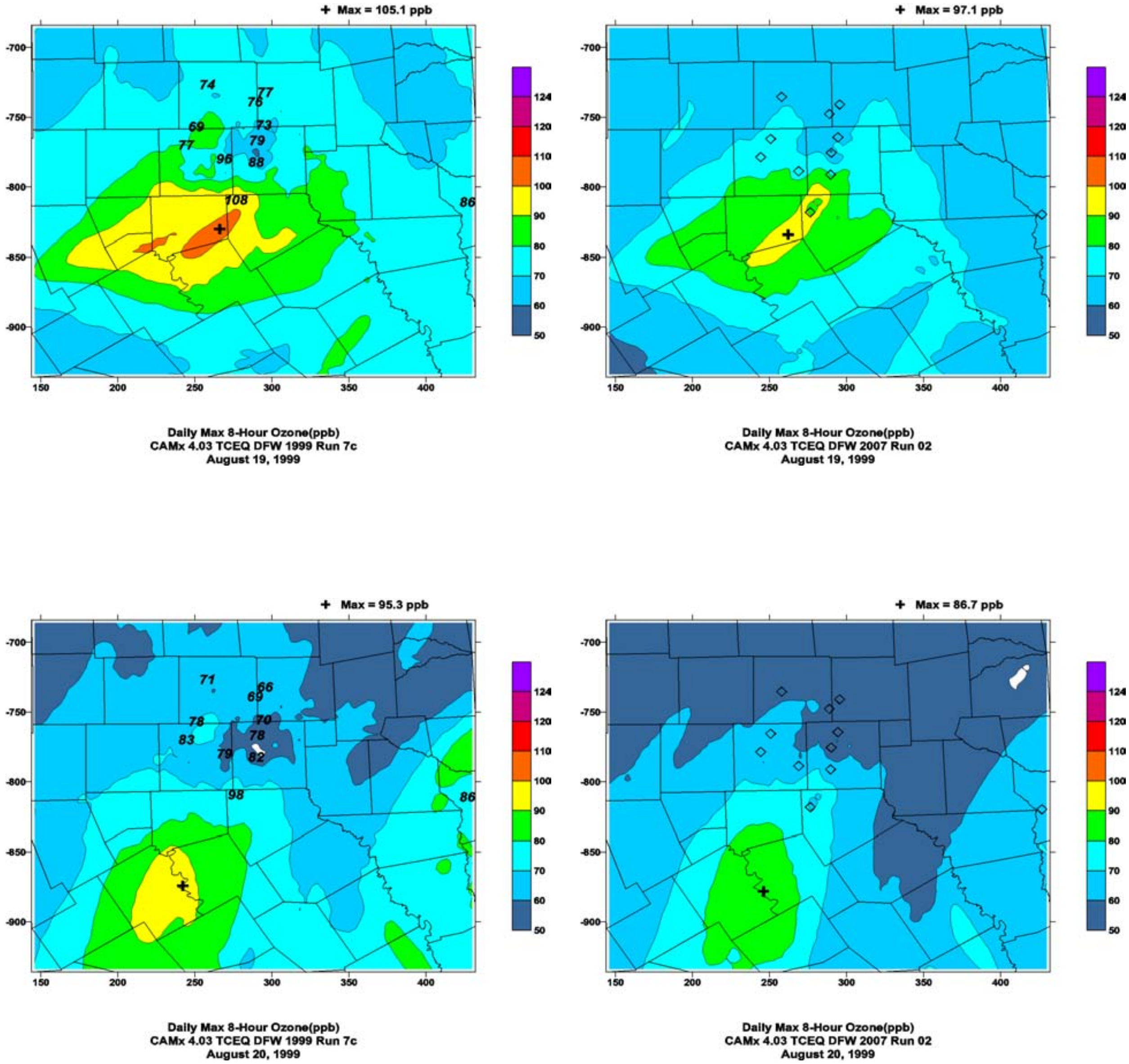


Figure 3-3 (cont.) Daily maximum 8-hour ozone in the DFW 4-km domain for 1999 and 2007.

1999 **2007**

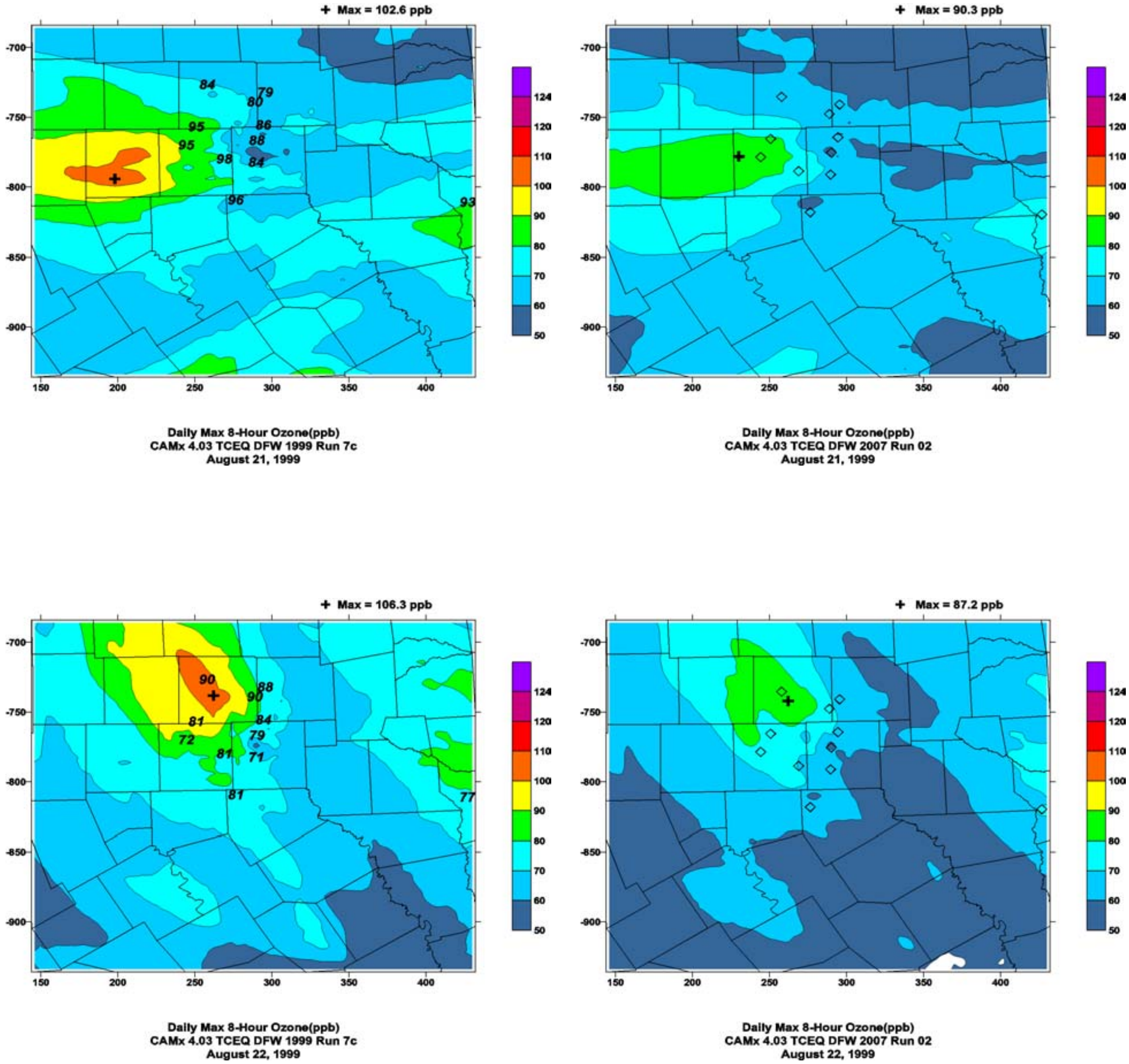


Figure 3-3 (concluded). Daily maximum 8-hour ozone in the DFW 4-km domain for 1999 and 2007.

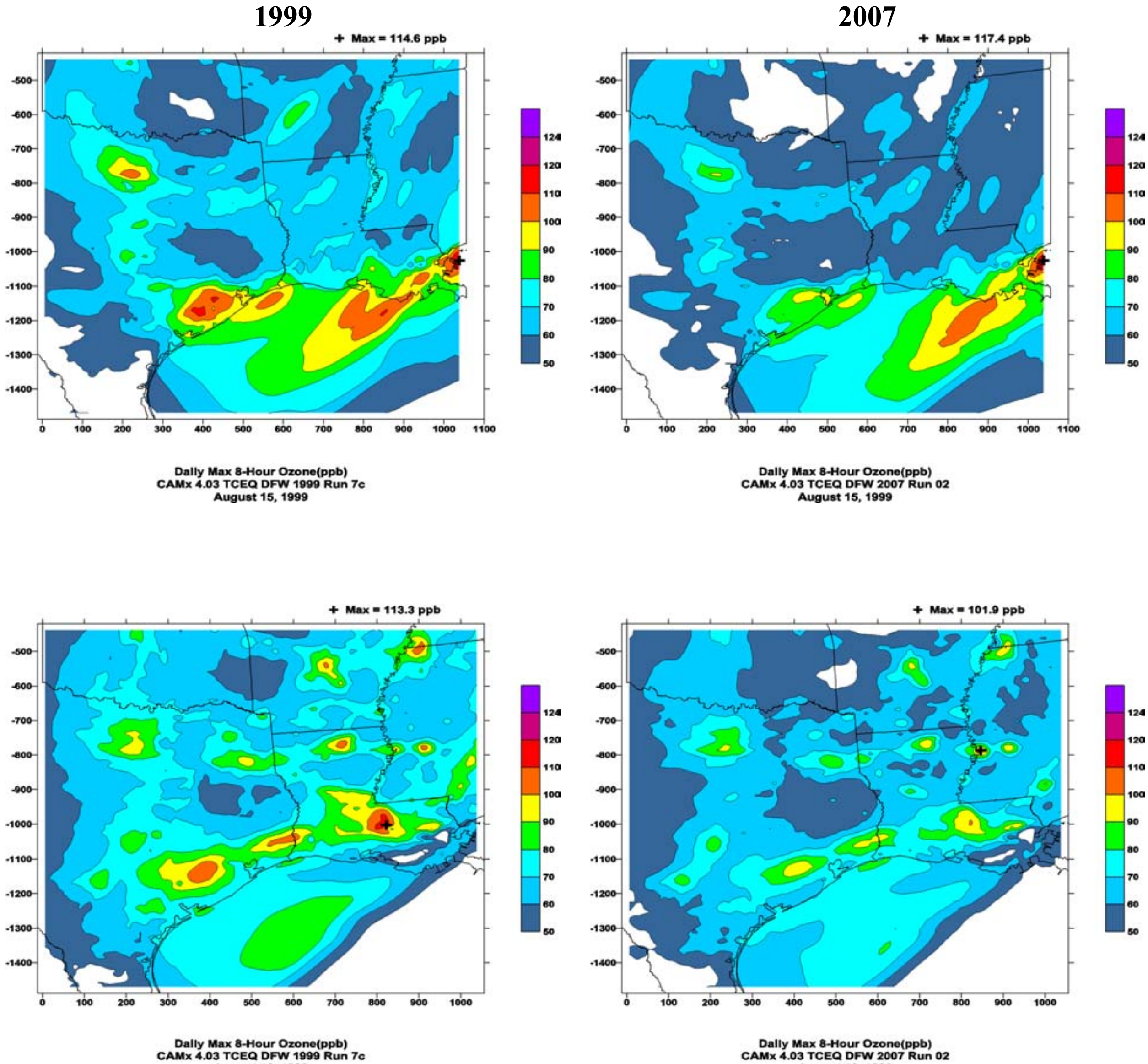


Figure 3-4. Daily maximum 8-hour ozone in the regional 12-km domain for 1999 and 2007.

1999 **2007**

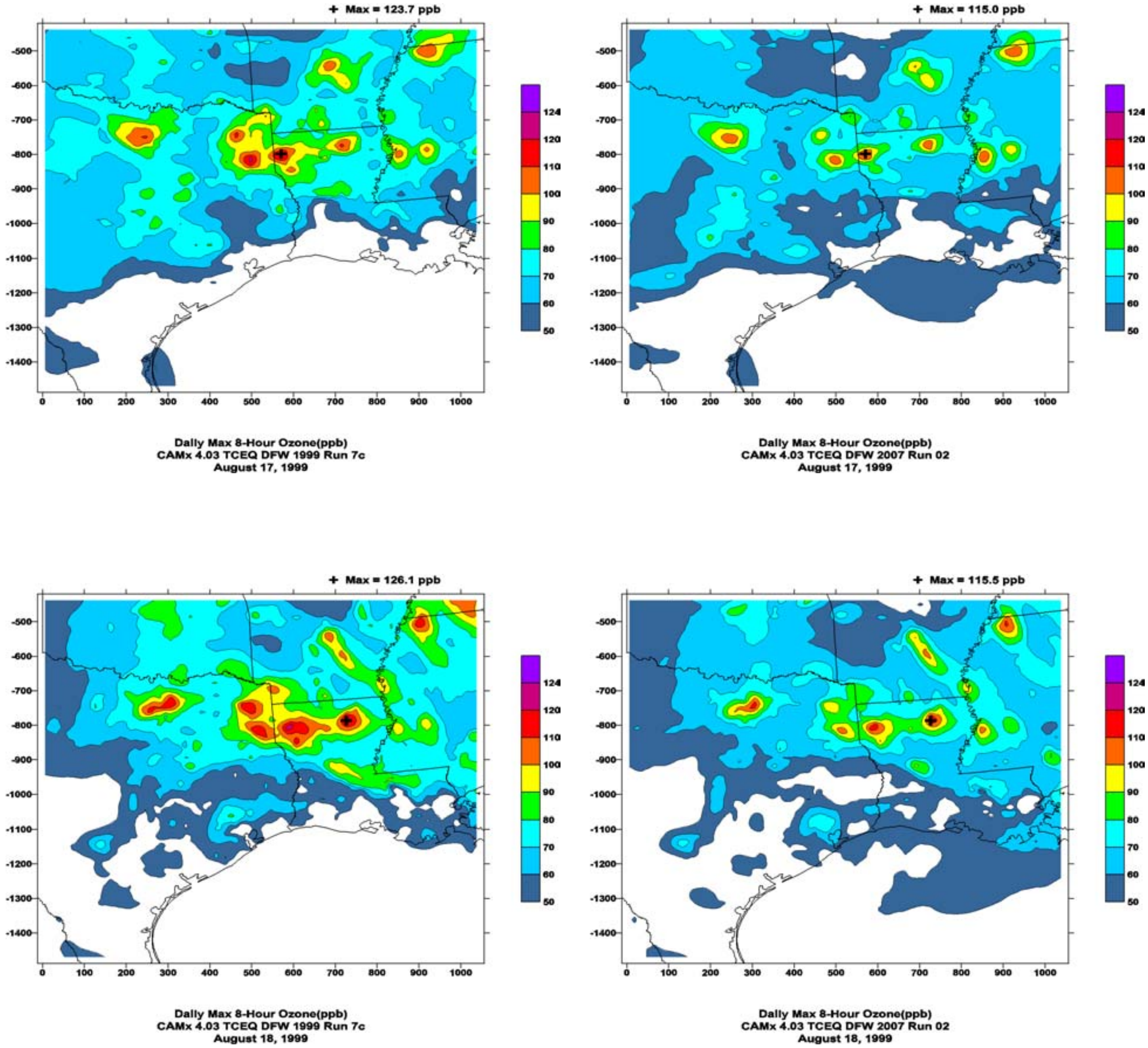


Figure 3-4 (cont.) Daily maximum 8-hour ozone in the regional 12-km domain for 1999 and 2007.

1999 **2007**

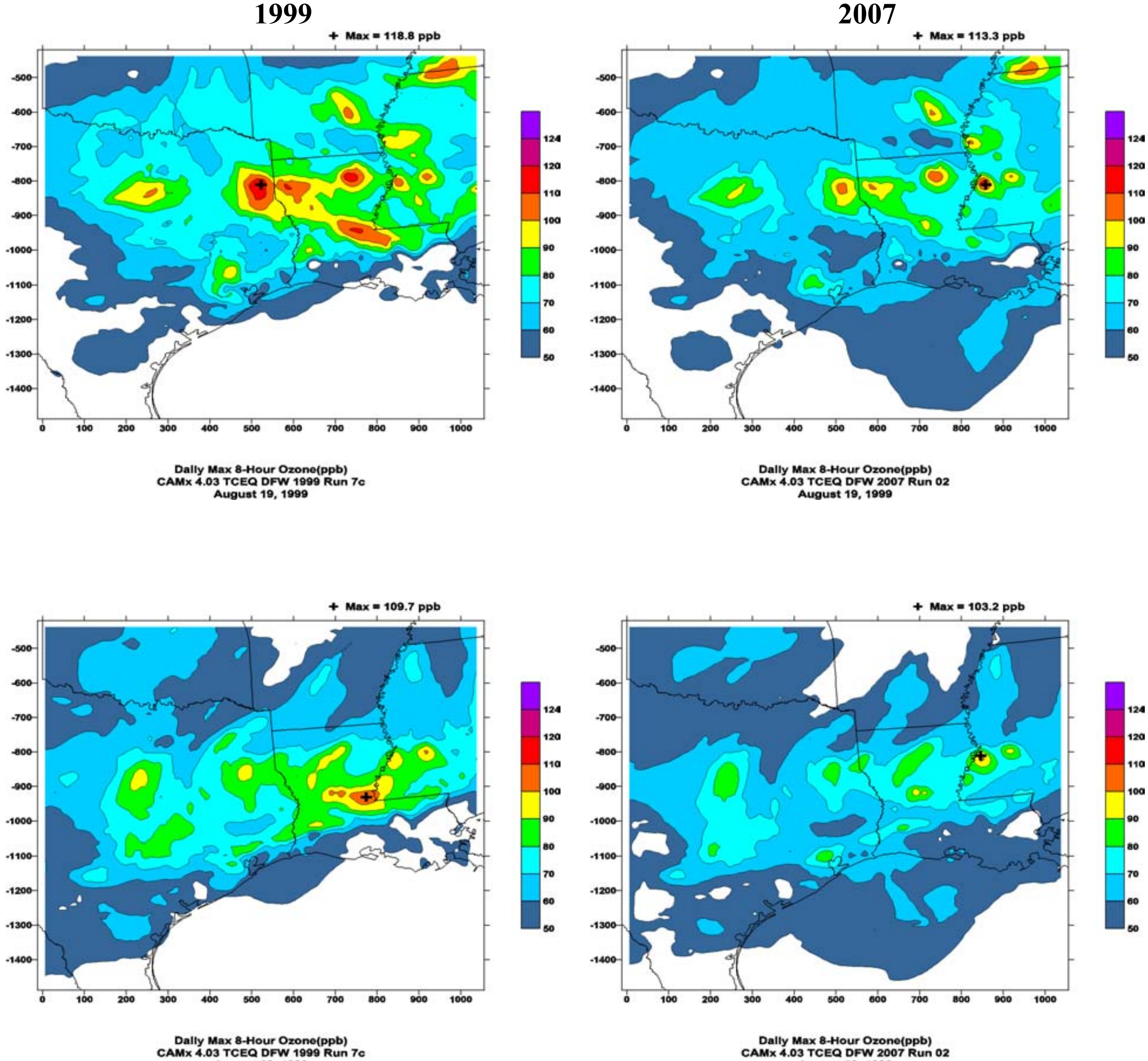


Figure 3-4 (cont.) Daily maximum 8-hour ozone in the regional 12-km domain for 1999 and 2007.

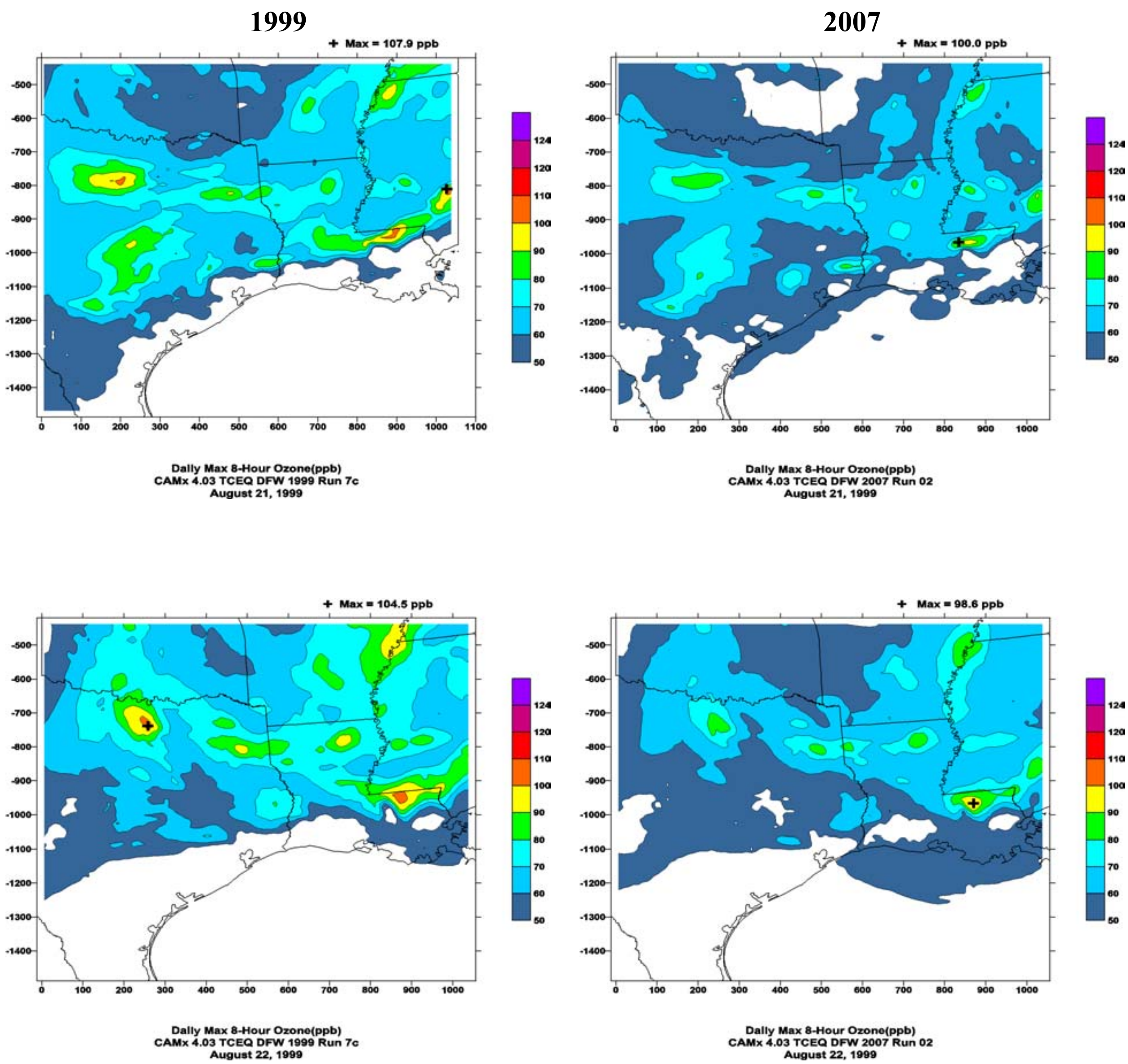


Figure 3-4 (concluded). Daily maximum 8-hour ozone in the regional 12-km domain for 1999 and 2007.

PROJECTED 2007 8-HOUR OZONE DESIGN VALUES

Design Value Scaling Methodology for 8-Hour Ozone

The methodology for the 8-hour ozone attainment test was described in draft modeling guidance issued by EPA (EPA, 1999). The methodology calls for scaling base year design values (DVs) using relative reduction factors (RRFs) from a photochemical model in order to estimate future design values using the following equations:

Future Year DV = Base Year DV × RRF

RRF = Future Year Modeled Ozone / Base Year Modeled Ozone

This methodology is conceptually simple, but the implementation is complicated and is described in detail below. This methodology was implemented in a computer program to automate the calculation for efficiency and reliability.

Calculating RRFs

RRFs are calculated for each monitor location. In addition, since high ozone can also occur away from monitor locations, a screening calculation is also carried out to identify grid cells with consistently high ozone. If any screening cells are identified, RRFs are then calculated for the screened grid cells. The idea behind the screening cells is to account for any areas with consistently high modeled ozone that are not captured by the monitoring network. Since there is no base year DV for a screening cell, the DV from a nearby representative monitor must be used. The attainment test is passed when all the future year scaled DVs are 84 ppb or less.

Figure 3-5 shows a schematic outline of the calculations and identifies the input data required to complete the calculation. These are:

1. A monitor list – the list of monitors along with base year DVs for each monitor.
2. A screening cell list – the list of cells to be considered in the screening cell calculation along with the monitors that are considered to be associated with that grid cell. This list may be a sub-set of the modeling grid covering just the area for which controls are being developed. The significance of associating monitors with each grid cell is in the selection of an appropriate base year DV for the grid cell and in setting concentration thresholds for including the grid cell in the screening calculation, discussed below. There are no firm criteria for deciding how to associate monitors with grid cells.
3. Base case ozone – gridded 8-hour daily maximum ozone for the base year.
4. Future case ozone – gridded 8-hour daily maximum ozone for the future year.

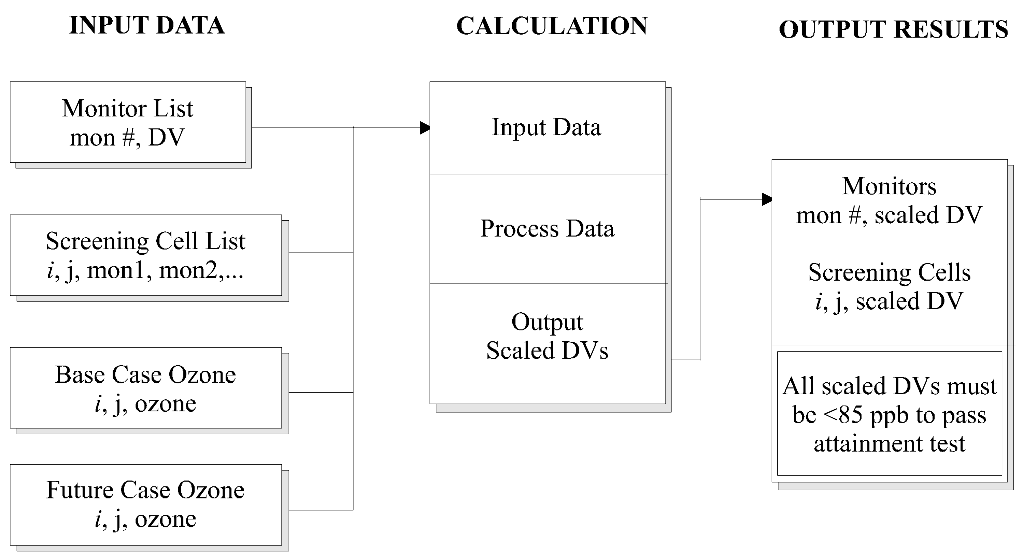


Figure 3-5. Overview of the 8-hour ozone attainment test methodology.

The details of the calculations are as follows:

- Monitor DV Scaling

1. For each monitor, find the daily maximum 8-hour ozone in an *n* x *n* block of cells around the monitor for both the base and future case. Repeat for each modeling day being used for control strategy development. For a 4 km grid, *n*=7 or 9 are consistent with the guidance.
2. Exclude days when the base case daily maximum 8-hour ozone was below 70 ppb.
3. Average the daily maximum 8-hour ozone across days for the base and future year.
4. Calculate the RRF = (average future daily max) / (average base daily max).
5. Calculate the scaled DV = base year DV x RRF and truncate to nearest ppb.
6. Repeat 1-5 for each monitor

- Screening Cell DV Scaling

7. For each grid cell on the screening cell list, count the number of days where the modeled daily maximum 8-hour ozone is at least 5% greater than the modeled daily maximum 8-hour ozone at any "associated" monitor, and at least 70 ppb.
8. If the number of days is 50% or greater of the total days, treat this cell as if it were a monitor – this is a "screened cell."
9. The base year DV to be used for a screened cell is the maximum of the base year DVs for any "associated" monitor.
10. Calculated the scaled DV for each screened cell as if it were a monitor (steps 1-5 above).
11. Repeat 7-10 for each grid cell on the screening cell list.

We make two deviations from EPA's draft guidance (EPA, 1999). First, in Step 4 the draft guidance says to round the average base and future daily maximum 8-hour ozone concentrations to the nearest ppb before calculating the RRFs, whereas we use the full precision of the modeled values. Rounding the average daily maximum 8-hour ozone concentrations in Step 4 doesn't make sense at this point in the calculations as it looses precision and will result in "stepfunction" RRFs that are illogical. The second deviation from EPA's draft guidance is that they recommend rounding the RRFs to 2 digits to the right of the decimal point, whereas again we use full precision. Again we believe this is an unnecessary loss of precision, however in this case it has little effect.

Dallas/Ft. Worth 8-Hour Design Values

The current 8-hour design values for the Dallas/Ft. Worth non-attainment area are presented in Table 3-2. The 8-hour design value for an individual monitor is defined as the fourth highest monitored 8-hour ozone value averaged over the most recent three years of data. EPA will use the 2000-2003 design values for 8-hour ozone attainment designations. However, because the modeling episode is for 1999, the EA modeling guidance (EPA, 1999) says that the design value scaling must consider the highest design value at each monitor over the period from 1998 to 2003.

The data presented in Table 3-2 includes all monitors with a 1998-2000 or 2000-2003 design value. Also presented in Table 3-2 is the highest 3-year design values based on 1998 to 2003 data. Figure 3-6 displays the location of ozone monitors within the DFW nonattainment area. The specific period for which the maximum design occurs is also denoted in Figure 3-6.

Table 3-2. DFW 8-Hour O3 Design Values.

County	City	CAMS	1998-2000	1999-2001	2000-2002	2001-2003	Max DV	Ending Year of Max DV
Collin	Frisco	C31	101	99	93	88	101	2000
Collin	Anna	C68			83	80	83	2002
Dallas	Dallas	C60,C401	93	92	91	90	93	2000
Dallas	Dallas	C63		93	89	86	93	2001
Dallas	Dallas	C402	88	82	82	83	88	2000
Dallas	Sunnyvale	C74				83	83	2003
Denton	Denton	C56	102	101	99	97	102	2000
Ellis	Midlothian	C94	97	88	86	82	97	2000
Hood	Granbury	C73			84	84	84	2002
Johnson	Cleburne	C77			89	90	90	2003
Kaufman	Kaufman	C71			70	73	73	2003
Parker	Weatherford	C76			86	89	89	2003
Rockwall	Rockwall	C69			83	81	83	2002
Tarrant	Arlington	C57	95	86			95	2000
Tarrant	Eagle Mountain Lake	C75			95	96	96	2003
Tarrant	Fort Worth	C13	99	97	96	96	99	2000
Tarrant	Fort Worth	C17	97	97	98	100	100	2003
Tarrant	Grapevine	C70			95	100	100	2003

ENVIRON

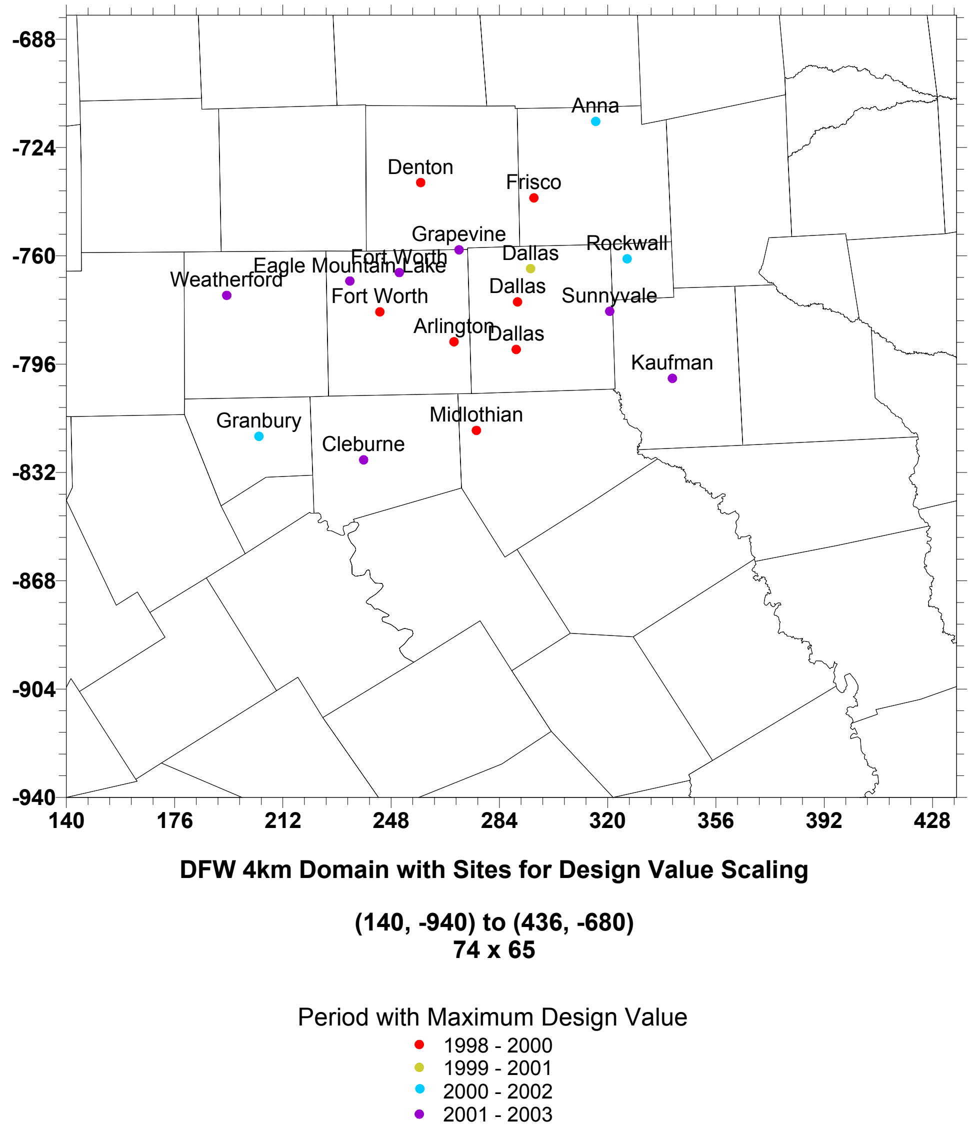


Figure 3-6. DFW ozone monitors and maximum design value periods.

The results of the design value scaling analysis are presented in Table 3-3. Yellow shaded values in the right hand column of the lower panel indicate monitors that fail the attainment test (8-hour O_3 < 85.0) for 2007.

Table 3-3. Preliminary 2007 8-hour ozone design value scaling analysis for monitors in the DFW area. The scaled 2007 design values are in the right hand column of the lower panel.

Base Case: run7c.403			Base Case Max 8-Hr Ozone (ppb)											#Days above 70 ppb
Site	MaxDV	DVyear	8/13	8/14	8/15	8/16	8/17	8/18	8/19	8/20	8/21	8/22	Avg	
Frisco	101	2000	57.5	64.8	76.3	80.8	92.5	122.7	75.2	66.3	72.8	93.9	87.7	7
Anna	83	2002	53.9	62.6	67.2	72.4	84.6	119.5	74.4	64.6	64.7	71.0	84.3	5
Dallas C60	93	2000	55.0	69.5	88.8	80.5	89.9	102.2	80.9	65.7	73.9	85.4	85.9	7
Dallas C63	93	2001	50.1	67.2	82.4	74.3	86.2	108.8	79.0	63.9	71.4	89.3	84.5	7
Dallas C402	88	2000	57.1	80.5	88.8	86.4	89.9	89.0	93.3	73.1	78.4	85.4	85.0	9
Sunnyvale	83	2003	62.8	65.9	71.6	71.4	78.0	89.9	81.5	66.5	70.2	69.1	77.1	6
Denton	102	2000	55.1	71.4	87.9	88.9	112.2	114.1	79.8	68.0	79.4	106.3	92.5	8
Midlothian	97	2000	55.6	79.7	79.4	79.8	79.7	79.5	105.1	80.1	73.2	77.9	81.6	9
Granbury	84	2002	48.8	101.1	85.6	84.4	77.3	76.0	97.8	78.0	94.1	72.5	85.2	9
Cleburne	90	2003	51.3	93.3	82.0	78.1	78.8	72.9	102.1	86.6	79.9	75.1	83.2	9
Kaufman	73	2003	54.0	64.8	75.5	68.3	71.7	73.1	82.1	65.4	71.6	65.3	74.8	5
Weatherford	89	2003	56.2	85.5	106.0	95.0	99.8	76.4	78.3	66.7	100.9	76.2	89.8	8
Rockwall	83	2002	62.2	65.9	65.4	72.1	80.3	106.5	81.5	64.7	71.9	70.0	82.5	5
Arlington	95	2000	57.1	87.8	97.5	89.7	94.8	91.7	93.3	73.2	85.1	85.8	88.8	9
Eagle Mt Lake	96	2003	56.0	85.2	111.0	97.2	110.8	109.1	84.3	70.7	99.9	94.3	95.8	9
Ft Worth C13	99	2000	56.4	82.6	108.2	97.2	106.0	109.8	84.1	72.5	95.5	91.6	94.2	9
Ft Worth C17	100	2003	57.6	79.0	104.3	94.5	111.7	116.5	82.9	72.5	91.7	100.0	94.8	9
Grapevine	100	2003	58.3	76.0	97.4	89.0	110.1	119.8	82.8	72.5	84.0	102.5	92.7	9

Future Year: 07run02.dfw			Future Case Max 8-Hr Ozone (ppb)												
Site	MaxDV	DVyear	8/13	8/14	8/15	8/16	8/17	8/18	8/19	8/20	8/21	8/22	Avg	RRF	2007 DV
Frisco	101	2000	52.8	61.9	67.2	78.6	89.3	118.5	69.4	60.2	65.8	79.0	81.1	0.9246	**93.4**
Anna	83	2002	51.0	55.0	59.0	65.5	77.2	107.7	68.5	59.7	58.5	61.4	76.1	0.9017	74.8
Dallas C60	93	2000	57.1	73.1	77.9	84.2	88.9	100.2	80.0	67.4	73.5	75.0	82.8	0.9639	**89.6**
Dallas C63	93	2001	56.3	66.2	75.1	80.0	86.5	110.9	76.3	63.9	69.2	78.0	82.3	0.9739	**90.6**
Dallas C402	88	2000	57.1	75.9	77.9	84.9	88.1	91.5	93.1	76.7	73.5	71.1	81.4	0.9580	84.3
Sunnyvale	83	2003	64.8	59.0	62.1	68.6	75.2	89.0	75.3	61.0	64.0	63.3	72.4	0.9388	77.9
Denton	102	2000	51.3	61.4	74.4	83.7	106.5	101.8	71.2	61.0	68.7	87.2	81.8	0.8847	**90.2**
Midlothian	97	2000	53.7	71.7	69.6	74.1	74.3	71.3	97.0	77.8	66.7	68.3	74.5	0.9133	**88.6**
Granbury	84	2002	48.7	88.7	78.1	76.6	71.6	70.8	87.3	73.0	81.4	66.3	77.1	0.9050	76.0
Cleburne	90	2003	48.5	81.1	75.1	73.2	73.4	65.3	93.1	82.8	75.4	63.7	75.9	0.9120	82.1
Kaufman	73	2003	53.2	55.4	60.6	63.2	64.1	66.3	76.9	57.5	63.8	58.0	66.4	0.8872	64.8
Weatherford	89	2003	49.7	75.5	91.6	89.1	90.4	67.4	70.6	61.2	89.0	67.1	80.1	0.8921	79.4
Rockwall	83	2002	64.8	59.0	57.7	67.0	74.3	100.6	75.3	59.5	62.8	62.9	76.0	0.9214	76.5
Arlington	95	2000	55.4	83.4	82.5	90.1	93.6	91.5	93.1	76.7	82.2	78.1	85.7	0.9653	**91.7**
Eagle Mt Lake	96	2003	51.6	79.3	94.6	94.5	107.5	95.3	75.9	64.7	90.3	82.6	87.2	0.9096	**87.3**
Ft Worth C13	99	2000	52.5	83.4	93.7	94.5	103.5	98.8	81.9	68.6	90.1	81.5	88.5	0.9394	**93.0**
Ft Worth C17	100	2003	52.7	77.0	90.5	93.7	109.9	102.4	77.4	64.8	88.3	84.2	87.6	0.9241	**92.4**
Grapevine	100	2003	54.0	73.1	85.0	87.9	109.7	107.6	74.6	64.8	81.1	86.1	85.6	0.9234	**92.3**

4.0 SUMMARY AND CONCLUSIONS

The CAMx air quality model was applied for the August 13 –22, 1999 Dallas/ Ft. Worth ozone episode. Version 4.03 of the CAMx air quality model was run for the 1999 base year and the 2007 future year. The development of the input databases for 1999 was documented in Mansell et al., 2003. Emission inventories for the 2007 future year were developed jointly by ENVIRON and TCEQ as described above. The main points from the ozone modeling results for 1999 and 2007 are summarized below.

Model Performance Evaluation

Model performance statistics for 1-hour ozone are shown in Table 3-1.

- The model performance for 1999 was slightly degraded by the change from CAMx 4.02 to CAMx 4.03.

- There was a reduction in regional ozone levels in the DFW area of a few ppb due the change in CAMx version.

- The episode peak 1-hour ozone was reduced from 151.1 ppb with CAMx 4.02 to 148.6 ppb with CAMx 4.03. These modeled values compare with an observed episode 1-hour peak ozone of 150 ppb.

- The normalized bias statistic was slightly more negative (by about 3 percentage points) on all days with CAMx 4.03 than CAMx 4.02.

- There was little change in the normalized gross error statistic between CAMx versions 4.02 and 4.03.

1-Hour Ozone for 2007

Peak 1-hour ozone levels for 2007 are shown in Table 3-1.

- Peak 1-hour ozone levels exceeded the level of the 1-hour ozone standard (124 ppb) on three days from August 17th to 19th.

- The 1-hour ozone peak on August 17th was 138.5 ppb for 2007 compared to 140.6 ppb for 1999. This peak value occurred downwind of DFW to the west and was not very responsive to the emissions reductions in the DFW area from 1999 to 2007. The observed peak ozone on 17 August 1999 was 150 ppb to the north of Dallas.

    - August 17th is the day with the poorest model performance due to a bias in the MM5 wind field (Mansell et al., 2003). The normalized bias for 17 August 1999 was –27%, which is outside the EPA goal of +/- 15%.

  - Because the modeled and observed peaks are in different locations, it is difficult to estimate whether a "relative reduction factor" analysis would find that 1-hour ozone levels are more responsive to emission reductions than the peak ozone.

- The 1-hour ozone peak on August 18th was 138.3 ppb for 2007 compared to 148.6 ppb for 1999. This peak value occurred to the north of DFW and was very close to the observed peak of 131 ppb for 1999.
  - Because the modeled peak is responsive to emission reductions and is located close to the observed peak, a "relative reduction factor" analysis is likely to suggest that 1-hour ozone levels would attain the standard on this day.

- The 1-hour ozone peak on August 19th was 125.4 ppb for 2007 compared to 135.9 ppb for 1999. This peak value occurred to the south of DFW. The observed peak for this day in 1999 was 128 ppb at the monitor closest to the observed peak, about 25 km away.
  - Because the modeled and observed peaks are in different locations, it is difficult to estimate whether a "relative reduction factor" analysis would find that 1-hour ozone levels are more responsive to emission reductions than the peak ozone.

8-Hour Ozone for 2007

Design values for 8-hour ozone in 2007 are shown in Table 3-3.

- A preliminary analysis was completed for 8-hour ozone levels in 2007 using EPA's design value (DV) scaling methodology. The analysis is preliminary because:
  - The final analysis will be for a 2010 future year.
  - The DV scaling method is sensitive to consistency between the base and future year modeling, and the base year inventory needs to be updated.

- The projected 8-hour design values for 2007 exceeded the target level of 84 ppb (after truncation) at 10 of 18 sites considered in the DFW area.

- The relative reduction factor analysis projected that only four monitors (Dallas CAMS402, Cleburne CAMS77, Weatherford CAMS76 and Rockwall CAMS69) would come into attainment of the 8-hour ozone standard by 2007.

- The highest projected 8-hour design values for 2007 was 93.4 ppb at the Frisco monitor.

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